INVESTIGATING THE TOTAL COST OF TECHNOLOGY IN SCHOOLS

Tools and Strategies for Managing Technology Investments

Best Practices For Alberta School Jurisdictions

June 2001

Information Technology Sharing Forum

Alberta LEARNING

ALBERTA LEARNING CATALOGUING IN PUBLICATION DATA

Alberta. Alberta Learning.
Investigating the total cost of technology in schools, tools and strategies for managing technology investments: best practices for Alberta school jurisdictions.

Available on the Internet: <http://www.learning.gov.ab.ca/technology/bestpractices/>

ISBN 0–7785–1313–0

1. Educational technology. 2. Education—Data process. 3. Computer-managed instruction. 4. Computer-assisted instruction. I. Title.

LB1028.43.A333 2001 370.285

For more information, contact:

Bonnie Brooks
Manager
Stakeholder Technology Task Group
Alberta Learning
11160 Jasper Avenue
Edmonton, Alberta, Canada T5K 0L2
Telephone : 780-427-9001
Facsimile : 780-415-1091

To be connected toll free outside Edmonton, dial 310-0000.

The primary intended audience for this framework is:

Administrators	✓
Counsellors	
General audience	
Information Technologists	✓
Parents	
Students	
Teachers	

Copyright © 2001, the Crown in Right of Alberta, as represented by the Minister of Learning. Alberta Learning, Stakeholder Technology Task Group, 11160 Jasper Avenue, Edmonton, Alberta, Canada, T5K 0L2.

Permission is given by the copyright owner to reproduce this document, or any part thereof, for educational purposes and on a nonprofit basis.

ACKNOWLEDGEMENTS

Alberta Learning wishes to acknowledge the contributions of the following individuals.

Project Director/Author

Pat Redhead	Edmonton School District No. 7

TCO Committee

Ray Battochio	William E. Hay Composite High School, Clearview School Division No. 71
Peter Darby	Stakeholder Technology Task Group, Alberta Learning
Maurice Hollingsworth	Palliser Regional Division No. 26
Ron Schlender	Edmonton Catholic Regional Division No. 40
Cindy Seibel	Calgary School District No. 19
Gary Spence	Wolf Creek School Division No. 72

Contributors

Sleight Anstruther	Vincent J. Maloney Jr. High School, Greater St. Albert Catholic Regional Division No. 29
Peter Balding	Black Gold Regional Division No. 18
Bonnie Brooks	Alberta Learning
Edna Dach	Elk Island Public Schools Regional Division No. 14
Donna Fedoration	J. J. Nearing Catholic Elementary School, Greater St. Albert Catholic Regional Division No. 29
Ron Giesbrecht	Georges H. Primeau School, Greater St. Albert Catholic Regional Division No. 29
Bette Gray	Parkland School Division No. 70
Avi Habinski	Edmonton School District No. 7
Gary Heck	Lethbridge School District No. 51
John Hogarth	Alberta Learning
Hans Hulstein	R. I. Baker School, Palliser Regional Division No. 26
Chris Jackson	James Gibbons Elementary School, Edmonton School District No. 7
Doug Knight	Alberta Learning
Ernie LaFebvre	H. E. Beriault School, Edmonton Catholic Regional Division No. 40
John Loree	Mike Mountain Horse Elementary, Lethbridge School District No. 51
Ralph Luedtke	Greater St. Albert Catholic Regional Division No. 29
Cathy Martens	Jennie Emery School, Palliser Regional Division No. 26
Darwin Martin	Edmonton School District No. 7
Norman Mathew	Ross Sheppard Senior High School, Edmonton School District No. 7
Bob McCulloch	MidSun Junior High School, Calgary School District No. 19
Norma Nocente	University of Alberta
Nick Parrotta	Bishop Greschuk School, Edmonton Catholic Regional Division No. 40
Vic Pedersen	Morinville Community High School, Greater St. Albert Catholic Regional Division No. 29
Carey Rowntree	Winston Churchill High School, Lethbridge School District No. 51
Jacquie Skytt	Alberta Teachers' Association
Allen Sorge	John Davidson School, Palliser Regional Division No. 26
Robert Steenwinkel	Mary Butterworth Junior High School, Edmonton School District No. 7
Wayne Street	R. I. Baker School, Palliser Regional Division No. 26

CONTENTS

EXECUTIVE SUMMARY **1**

CHAPTER ONE: THE COST OF TECHNOLOGY **3**

Introduction 3
Defining Total Cost of Ownership 3
A TCO Model for K-12 Schools 4
Calculating the Cost of Technology 6
Key Messages in Chapter One 9

CHAPTER TWO: THE VALUE OF TECHNOLOGY **11**

Defining Value 11
Calculating the Value of Technology 12
Performance Measures 12
Rating Scale 16
Key Messages in Chapter Two 21

CHAPTER THREE: MINIMIZING THE COST OF TECHNOLOGY **23**

Strategies to Control Costs 23
Cost-control Strategy No. 1: Plan and manage. *24*
Cost-control Strategy No. 2: Reduce complexity. *26*
Cost-control Strategy No. 3: Increase reliability. *28*
Cost-control Strategy No. 4: Provide user support. *29*
Using the Strategies 30
Key Messages in Chapter Three 31

CHAPTER FOUR: PLANNING FOR TECHNOLOGY **33**

TCO Is Good Planning 33
TCO Improvement Project 33
School Technology Planning 35
How Much Is Enough? 37
Key Messages in Chapter Four 37

BIBLIOGRAPHY **39**

APPENDIX A: CALCULATING THE COSTS OF TECHNOLOGY **43**

Part A—School Costs 43
Part B—Shared Jurisdiction Costs 48
Part C—TCO Analysis of Costs 51

APPENDIX B: CASE STUDIES 52

School A—Case Study 53
School B—Case Study 54
School C—Case Study 55
School D—Case Study 56
School E—Case Study 57
School F—Case Study 58
School G—Case Study 59
School H—Case Study 60
School I—Case Study 61
School J—Case Study 62
School K—Case Study 63
School L—Case Study 64
School M—Case Study 65

APPENDIX C: SURVEYING THE SATISFACTION OF STUDENTS AND STAFF 66

APPENDIX D: RATING THE QUALITY OF THE TECHNOLOGY INVESTMENT 69

APPENDIX E: PLANNING SCENARIOS 74

Scenario No. 1 74
Scenario No. 2 75

LIST OF FIGURES

FIGURE 1: SIMULATED CYCLE OF TECHNOLOGY COSTS (5-YEAR CYCLE)..... 7

FIGURE 2: COST VS. VALUE..... 11

FIGURE 3: GRAPHICAL REPRESENTATION OF DATA..... 14

FIGURE 4: EXCERPT FROM TECHNOLOGY EVALUATION RUBRIC, NCREL..... ... 17

FIGURE 5: STAGES OF PROGRESS, MILKEN FAMILY FOUNDATION..... 18

FIGURE 6: STAGES OF EVOLUTION IN IMPLEMENTING TECHNOLOGY, EDMONTON SCHOOL DISTRICT NO. 7..... 18

FIGURE 7: PLANNING CYCLE FOR TECHNOLOGY..... 24

FIGURE 8: SCHOOL TECHNOLOGY PLANNING..... 35

EXECUTIVE SUMMARY

Total cost of ownership (TCO) is an analysis of all of the costs of computer technology in a school in comparison to the value that is derived from the current investment. A TCO analysis also includes an assessment of strategies that can be implemented to reduce costs. The TCO model used in this document identifies six categories of costs: hardware, resources, infrastructure, technology support, professional development, and management and planning.

The first stage in an analysis of TCO in a school or jurisdiction is to measure all of the costs. The TCO instrument provided in this document has proven to be effective for this purpose as well as for planning a technology budget. Generalizations cannot be drawn from the data reported in the case studies, however. Schools cannot be compared without strict control of the variables.

Determining costs is just the first step in a cyclical and ongoing process of planning effectively for technology in schools. The school technology planning process should be based on continuous improvement of TCO, keeping the costs down while maintaining the value of technology to the school.

The second stage in a TCO analysis is to collect data about the value derived from the investment so that value can be compared to costs. Value is defined in terms of goals. The performance measure method of determining value consists of identifying measures based on the goals established by the school in its technology plan. A rating scale can also be used to compare the value of the technology investment in one school to an ideal or standard, or to compare value across schools based on a common set of indicators.

The third stage in a TCO analysis is to compare the school's decisions and practices to cost-saving strategies. Four general strategies can be used to minimize the cost of technology:

- Plan and manage.
- Reduce complexity.
- Increase reliability.
- Provide user support.

Understanding TCO is a step forward in the evolution of effective technology planning in schools and jurisdictions. It is about cost-effective ownership, not the total cost of ownership. A short-term TCO improvement project can be planned to reduce the costs of technology. Technology planning should also be infused into the three-year planning cycle of the school.

CHAPTER ONE
THE COST OF TECHNOLOGY

"As a major Silicon Valley newspaper notes in late 1998: The question asked in the mid-90's, amid the optimistic din created by high tech, was, 'How do we get more computers in our classrooms?' Swiftly, that question has given way to one more difficult – 'How can we afford to keep them?'"

— The Consortium for School Networking

Introduction

Many questions are being asked about the cost of computer technology in schools. How much funding should be allocated to technology? Is technology eating up too much of the school budget? Is technology worth the cost? How much is enough to spend on technology support and professional development? Many school administrators are asking these questions as they try to budget effectively for technology in their schools, using funding made available through government—instructional block funding, support block funding, capital block funding, technology integration funding—and other sources.

This document provides educational decision makers in Alberta, such as superintendents, school administrators, jurisdiction information technology (IT) managers and school board trustees, with the information and tools needed to understand, control and plan for all of the costs related to computer technology in schools. The purpose of this document is not to justify the expense of technology in schools but to provide tools that can be used to answer the real question: "What is the right amount to spend on technology in your school to achieve your goals?" The methods of measuring the total cost of ownership of technology (TCO) in this document are tailor-made to Alberta's kindergarten to grade 12 (K-12) educational settings.

Thirteen schools representing seven school jurisdictions volunteered to develop and refine the data collection instruments. Through this process, data was also collected that shows a snapshot of the cost of technology in a small number of Alberta schools at one point in time.

The TCO framework in this document is more important than the numbers, however. Total cost of ownership is really about effective planning for technology. As such, this project contributes to a new understanding of the nature of jurisdiction and school technology planning in Alberta.

Defining Total Cost of Ownership

Schools are not alone in their concerns about the costs and their search for ways to keep costs down. The concept of total cost of ownership (TCO) has also emerged in recent years as a key issue for businesses and industries that use computer technology.

The GartnerGroup <http://www.gartner.com>, a U.S.-based consulting organization that provides IT services such as research, measurement and decision support, has led the way in working with organizations and businesses to develop the theory of TCO. Although the GartnerGroup's work is not directly related to K-12 education, it has formed the foundation of the studies of TCO in school settings done by other organizations such as Microsoft and the Consortium for School Networking (CoSN).

The GartnerGroup states, "Our current definition of TCO is that it is a holistic view of IT costs across enterprise boundaries over time." (*What is the role of TCO in IT and business management?*, 1999).

Microsoft Corporation <http://www.microsoft.com/technet> has contributed to an understanding of TCO by publishing white papers on its TechNet web site; for example, "Lowering Total Costs in Education." This paper states, "TCO, or total cost of ownership, has its origins in the green-eyeshade world of accounting—akin to return on investment, revenue streams and profits. It aims to measure all the expenses associated with technology beyond its initial budgeted and direct costs of hardware and software to cover areas that are indirect and often unbudgeted—including training, support and more." (Sustar, 2000).

CoSN, the Consortium for School Networking <http://www.cosn.org>, published the first comprehensive report on TCO in K-12 schools, "Taking TCO to the Classroom." CoSN is a non-profit U.S. association that "promotes the use of telecommunications to improve K-12 learning." This paper states, "Total cost of ownership...includes all of the costs associated with using and maintaining networked computers, no matter whether a school district owns or leases them. TCO traditionally also includes calculations of costs that may not turn up in a budget, but that can still have an impact on school district operations—for example, when computers sit idle because they need to be repaired or when teachers can't use them because there is no money available to train staff members." (CoSN, 1999).

This document combines the theoretical frameworks of these three organizations with the insights of other authors listed in the bibliography and the practical experiences of selected schools and jurisdictions in Alberta. (Some articles were not listed in the bibliography because of a bias toward specific products or for-profit solutions). Everyone agrees that the scope of total cost of ownership is broader than just costs; it must also include an examination of value and strategies to keep costs down.

The definition of TCO used in this document is:

> ***Total cost of ownership (TCO) is an analysis of all of the costs of computer technology in a school in comparison to the value that is derived from the current investment. A TCO analysis should also include an assessment of strategies that can be implemented to reduce costs.***

A TCO Model for K-12 Schools

The GartnerGroup, Microsoft and CoSN have developed models of conceptualizing TCO as a way to simplify a complex topic. Each model is based on a scenario that describes a typical setting that could apply to any number of actual organizations, businesses or schools. Each model also includes a detailed list of costs, organized into major categories. According to TCO theory, cutting costs in one area, such as technology support or training, can actually increase costs in other areas, such as repairs.

The GartnerGroup, for example, states that their model "does not represent any particular enterprise using any specific product. It is a general study composed of a cross-section of the enterprises with which GartnerGroup analysts speak. The model examines computing costs for a 2,500-user campus LAN organization. We assume the enterprise is centrally administered and we assume a standard suite of office automation, E-mail and other packaged software." (Dec et al, July 1996).

The Gartner model also assumes that there will be 100 users per network server and 60 users per Windows terminal server. There are multiple generations of PCs in the scenario, and wide area network costs are outside the scope of the model.

GartnerGroup divides its model into four categories—capital, technical support, administration and end-user operations. Each category is further divided into desktop and network components.

The Microsoft TCO model organizes costs into seven key sub-categories. Budgeted costs are defined as hardware and software costs, management costs, development costs, support costs and communication costs. The model recognizes two types of unbudgeted costs: end-user costs and downtime costs.

CoSN identifies six categories that are relevant to school jurisdictions: retrofitting, professional development, software, support, replacement costs and connectivity. Their work is based on a number of other studies, each with their own assumptions. For example, one such study used three classroom scenarios to calculate the costs—the classroom model, the partial classroom model and the lab model.

In this document, computer technology is considered holistically across the entire school. Therefore, all work stations for both students and staff are included in data collection and analysis. It is assumed that the school has a local area network (LAN) with connections to most classrooms, the office, school library and computer laboratories and that the school LAN is part of a jurisdiction wide area network (WAN) with access to the Internet. However, the instruments can be used in any setting because cost categories that do not apply can be omitted.

In elementary schools, it is assumed that computers are used across the curriculum and for Information and Communication Technology (ICT) but not as a discrete course of study. Computers may be located in classrooms, the library or labs. Students remain in cohort groups in classrooms with a single teacher.

In secondary schools, it is assumed that computers are used across the curriculum, for ICT and for Career and Technology Studies (CTS) courses. Students move to different classrooms for courses with a number of teachers. Computers may be located in classrooms, the library or labs. Stations in CTS labs have some high-end applications.

In both settings, teachers use computers for teaching, research, information management and communication. Teachers have access to a work station in their homeroom or in shared spaces such as classrooms, the staff room, the teachers' workroom or the department office. Secretaries and other office staff use computers at work stations that are for their use only.

The TCO model described in this document identifies six categories of costs that apply to K-12 schools:

1. Hardware

   Hardware refers to the computer equipment and peripheral devices used by students and staff. For example, hardware includes CPUs, disk drives, monitors, keyboards, printers and projectors.

2. Resources

   Resources are the software, applications, Internet subscriptions and consumable supplies used by students and staff. Resources also include print materials, such as textbooks and manuals, used by students and staff to learn how to use technology.

3. Infrastructure

   Infrastructure includes all components that are provided in the school building to make it possible to add computer work stations to the network, which consists of the school's local area network, the jurisdiction's wide area network and the Internet.

4. Technology Support

   Technology support is the service provided by school staff, jurisdiction staff, vendors or third-party contractors to keep the hardware, software and infrastructure functioning effectively and efficiently. It also includes the cost of maintaining the school's web site or intranet. Technology support includes formal technology support only, not informal support such as staff members helping each other to solve problems.

5. Professional Development

   Professional development (PD) refers to activities that are used to assist staff in learning to use technology effectively and efficiently. PD includes formal activities only, not informal activities such as staff helping each other to learn new things.

6. Management and Planning

   Management and planning includes budget planning for technology as well as the management of technology infrastructure, hardware and resources.

Calculating the Cost of Technology

There are three stages in a complete analysis of the total cost of ownership of technology. The first stage is to measure all of the costs. The second stage is to determine the value derived from the investment. The third stage is to assess how well cost-saving strategies have been implemented. Only after all three stages have been finished can judgments be made about "how much is enough."

This document provides an instrument based on the TCO model that both elementary and secondary schools can use to calculate the cost of technology and collect data to compare costs across jurisdictions. (See Appendix A).

The data collection instrument answers questions such as these about a school:

- What is the total annual cost of computer technology in the school?
- What proportion of the total cost of technology is spent on each category; i.e., hardware, resources, infrastructure, technology support, professional development, and management and planning?
- For each computer in the school, how much is spent annually on technology?
- For each student in the school, how much is spent annually on technology?

A summary of the data collected by the schools involved in the case studies is provided in Appendix B.

To use the instrument effectively, follow these steps:

Step 1: Decide what is in scope and what is out of scope.

Many aspects of calculating the cost of technology pose a challenge. The first is defining technology so that it is clear what costs should be included and excluded from the analysis. In this document, technology refers to computer work stations, peripheral devices and networking infrastructure. Therefore, digital cameras and graphing calculators that interface with computers in the school are included. If they function independently, they are not.

Attributing costs to technology is becoming increasingly difficult as digital technology becomes more pervasive in our lives. For example, the case studies excluded environmental control systems, engine analyzers, lathes, sewing machines, elevators and telephone voice mail systems, even though they are based on digital technology.

The hidden or indirect costs of technology are also a challenge because they are very difficult to quantify. For example, technology may contribute indirectly to the amount of paper used in the school when documents are delivered electronically and printed using school resources. Indirect costs also include downtime or lost productivity and the time users spend troubleshooting, learning new things and helping others. Indirect costs such as these were determined to be outside the scope of the case studies. Therefore, only direct costs are measured in the instrument.

In a similar vein, the instrument does not account for savings that can be attributed to technology, such as a decrease in the cost of postal mail or jurisdiction distribution systems because of increased use of e-mail and the Internet.

Before using the instrument, schools should try to reach a consensus about the definition of technology, including what will be in scope and out of scope, and revise the instrument to reflect these decisions.

Step 2: Collect data about the school's costs.

Another challenge in calculating the cost of technology is that costs vary significantly from year to year even though education funding remains relatively constant. The costs are typically highest in the first year when new hardware, software and infrastructure components are purchased and when initial training occurs. In the next two to three years, costs level out and consist of ongoing costs such as upgrades, repairs, salaries, annual licences and monthly charges for electrical power and Internet services. In later years, the costs begin to increase again as repairs and upgrades are required to maintain aging hardware. This cycle, referred to as the evergreen cycle, can be represented as shown in Figure 1.

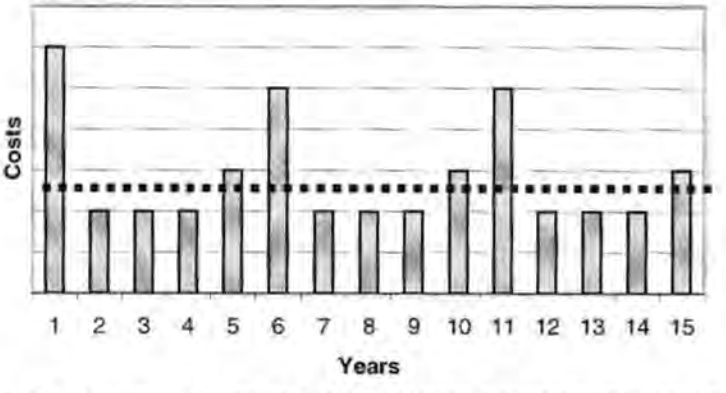


FIGURE 1: SIMULATED CYCLE OF TECHNOLOGY COSTS (5-YEAR CYCLE)

The graph depicts an evergreen cycle that involves replacing hardware every five years or amortizing costs over five years. Some components such as network wiring and furniture last longer and are included only once in the 15-year cycle. Others, such as servers, are replaced every three years. The dashed line represents the average cost of technology over the entire 15-year cycle.

The instrument creates a one-year snapshot of technology costs that includes annual costs as well as long-term investments. The result is an average annual cost per student, even though actual costs may peak in certain years.

Collecting the data about technology costs is a forensic activity. Schools can collect some of the data by counting the number of computers and peripherals in the school and multiplying by the average purchase price. They can also review the service bills paid in the previous year or ask staff to list all the conferences and workshops they attended.

Include all costs, no matter where the funding came from. Government funding for technology is provided in several ways—through instructional funding, support funding, capital funding and the technology integration grant <http://www.learning.gov.ab.ca/funding/default.asp>. Funding is also indirectly provided through projects such as Computers for Schools <http://www.learning.gov.ab.ca/cfs/>, which provides donated computers, and subsidized professional development initiatives such as Industry Canada GrassRoots funding, the TELUS Learning Connection <http://www.2learn.ca>, the Galileo Educational Network <http://www.galileo.org> and the Teaching and Learning with Technology <http://www.tlt.ab.ca> program. Some schools engage in their own fundraising activities as well to increase their ability to pay for technology.

Step 3: Add the school's share of jurisdiction costs.

To get an accurate picture of all of the technology costs, include things that the jurisdiction's central office has provided "free" to the school. To a greater or lesser extent, all jurisdictions spend some of the funding centrally on behalf of the schools. If the intent of the TCO analysis is to compare costs across schools in different jurisdictions or to calculate the total cost of technology for an entire jurisdiction, knowing these amounts is important. If not, this step can be omitted.

Each of the case studies in Appendix B, which represent seven school jurisdictions, has factored in shared jurisdiction costs that clearly had a strong school component. Other costs that were more closely related to the functioning of business practices in the jurisdiction's central office, such as financial and payroll systems, were excluded.

Step 4: Summarize the data.

Once the data has been entered into the spreadsheet, a summary of technology costs in each category will be generated as well as answers to the original questions.

At this point, it is natural to try to make judgments to determine whether the right amount is being spent in the right categories. One way to judge costs is to compare the school's costs to those reported by other schools and organizations. GartnerGroup, Microsoft, CoSN and others have attempted to quantify the cost of technology per user. The difficulty in using their figures is that each study is based on a different set of assumptions and parameters.

Comparing technology costs in schools to those in business is particularly problematic because educational settings are different in several ways. "Schools purchase less expensive PCs at larger discounts than businesses do, educational software packages are priced lower than business software applications, schools use roughly half the number of people that businesses do to support the same number of PCs and schools typically use their computers for five years." (Taking TCO to the Classroom, 1999).

There must be strict control of variables before comparisons among schools can be made. Do not be tempted to compare your school's costs to those reported in the case studies in Appendix B because the sample size is too small to make valid generalizations and there are significant differences in demographics, location and deployment among the schools.

A better way to judge the school's costs is in relation to the value derived from that school's investment.

Key Messages in Chapter One

- Total cost of ownership (TCO) is an analysis of all of the costs of computer technology in a school in comparison to the value that is derived from the current investment. A TCO analysis also includes an assessment of strategies that can be implemented to reduce costs.
- The TCO model used in this document identifies six categories of costs: hardware, resources, infrastructure, technology support, professional development, and management and planning.
- The first stage in an analysis of TCO in a school or jurisdiction is to measure all of the costs. The TCO instrument provided in this document has proven to be effective for this purpose as well as for planning a technology budget.
- Generalizations cannot be drawn from the data reported in the case studies, nor can schools be compared, because the variables have not been strictly controlled.

CHAPTER TWO
THE VALUE OF TECHNOLOGY

"It isn't always what you pay. It is what you get in return. Value."

— Mercedes Benz

Defining Value

Value in the context of TCO is an exploration of the benefits or results derived from the school's investment in computer technology. The process is similar in some ways to accounting practices such as calculating the return on investment, conducting a cost-benefit analysis or reporting on performance measures in a business plan. Is the school achieving its goals by spending this much? Was the money well spent? Is enough being spent on technology support and professional development? Are there areas for improvement?

Each school strives to achieve good value from its investment in technology. Figure 2 depicts the balance between cost and value.

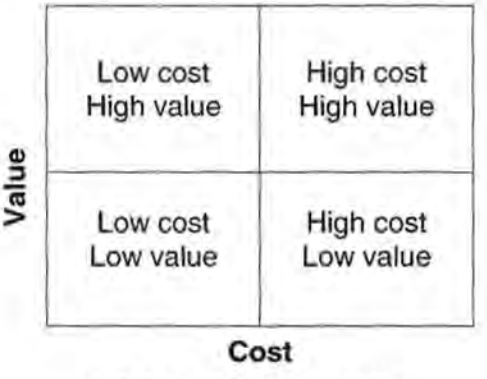


FIGURE 2: COST VS. VALUE

Value should be defined in terms of the way technology has been implemented, not why technology is implemented. Evaluation methods such as using control groups, selecting random samples and calculating gains in achievement on standardized test scores are appropriate for educational research to answer the question, "Is technology valuable and can it improve student learning?" These methods are not the best ways to measure value, however, in the context of a TCO analysis. In other words, schools should measure value in relation to the goals stated in the technology plan and not in relation to the effectiveness of the technology. Computer technology helps the school to achieve two general goals:

1. To provide a quality education for all students.
2. To help staff work effectively and efficiently.

Since technology is an enabler for achieving these high-level goals, the goals in a school technology plan are commonly stated more concretely. For example, the school's technology plan may refer to implementation of the Information and Communication Technology (ICT) curriculum, increased access to computers for students, and developing the skills of teachers so that they can use a computer information system to create student progress reports.

If a TCO analysis is being undertaken and there is no written technology plan, the goals must be articulated before value can be determined. For example, it may be necessary to interview staff to understand what goals they had in mind when purchasing decisions and implementation plans were made.

The indicators selected to measure these goals add detail to the definition of value. In business and industry, for example, the value of technology may be measured in terms of productivity, profitability, revenue, competitive advantage, market share, customer satisfaction, system performance, service levels, the time it takes to get a product to market and gains in efficiency. Educators can measure the value of technology in terms of:

- The student-to-computer ratio.
- Student enrollment in Career and Technology Studies (CTS) courses.
- The speed of the network.
- The number of teachers who have e-mail.
- The satisfaction of students with the opportunities they have to learn to use technology.
- The number of students who have the knowledge, skills and attitudes defined in the Information and Communication Technology (ICT) Program of Studies.

The process of selecting the best measures will result in a common definition of value as well as a deeper understanding and commitment to the school's goals.

Calculating the Value of Technology

Calculating the value of technology is not as easy as calculating the costs because value is subjective. Schools can create a definitive list and attribute a dollar value to all of the items and services that constitute the costs of technology, but measures must be identified to serve as proxies for value. As the GartnerGroup admits, "Quantifying the value of distributed computing is more of (an art) than a science and detailed methodologies do not exist." (Dec et al, 1996).

Two different methods of calculating value are described in more detail throughout the rest of this section—performance measures and the rating scale method. Both methods can be used for planning purposes, such as determining whether the goals identified in the school technology plan have been achieved and identifying areas for improvement.

Performance Measures

The performance measure method of determining value consists of identifying measures based on the goals established by the school in its technology plan. This method is consistent with planning processes based on continuous improvement, which monitors progress and identifies areas for improvement.

Performance measures are a familiar process for school administrators, and they integrate well with existing practices. Schools and jurisdictions use this method to monitor their three-year plans, report to stakeholders and plan improvements. The Alberta Learning *Guide for School Board Planning and Results Reporting* describes the process <http://www.learning.gov.ab.ca/department/planning/SchoolGuides/SchBdGuide/>.

An example of a performance measure for one school jurisdiction in Alberta demonstrates the relationship between goals and measures:

Goal: Students have information technology skills needed for K-12 learning, work and post-secondary studies.

Measure: Percentage of students satisfied that they have the grade-appropriate skills to use information technology

Several other measures could have been used to demonstrate the value of technology. For example:

- The percentage of students leaving grades 3, 6, 9 and 12 who have achieved the learner outcomes in Information and Communication Technology (ICT) for their jurisdiction.
- The percentage of parents who believe that high school graduates have obtained basic technology knowledge and skills before entering the workplace or pursuing further studies.

In the following example from another school jurisdiction, five measures are used for one of the goals in the jurisdiction technology plan:

Goal: All students will have access to and use technology to enhance learning across the curriculum.

Measure: Student-to-computer ratio (District Technology Plan Survey)

Measure: Percentage of schools with a 5:1 student-to-computer ratio (District Technology Plan Survey)

Measure: Percentage of students who respond "Yes" to the question, "Do you use computers at your school to help you learn?" (District Attitude Survey)

Measure: Schools' ratings of how extensively technology is being used to enhance instruction rather than being taught as a course: very much, somewhat, not at all (District Technology Plan Survey)

Measure: Parents' responses to the question, "How satisfied are you with the way computer technology is used in your school?" (District Attitude Survey)

This school jurisdiction also used a table to indicate the progress it had made for the first measure, the student-to-computer ratio. The table also includes a target and when it will be achieved.

1995	1997	1998	1999	2000	Target 2003
22:1	11:1	9.6:1	9.4:1	7.8:1	5:1

A third school jurisdiction used four measures for a goal related to technology access. Graphs were used effectively to display annual data for some of the measures (see Figure 3):

Goal: Ensure that all school sites have increased opportunities to access technology for purposes of integrating it as part of the regular learning process; to support alternate delivery models; and to improve the overall accuracy, timeliness and efficiency of information transfer.

Measure: The percentage of students who were satisfied that they had the skills to use information technology

Measure: The percentage of parents who reported satisfaction that schools were helping to improve students' computing skills

Measure: The percentage of teachers who reported satisfaction that their access to technology has increased

Measure: The percentage of sites with a local area network that are also connected to the wide area network

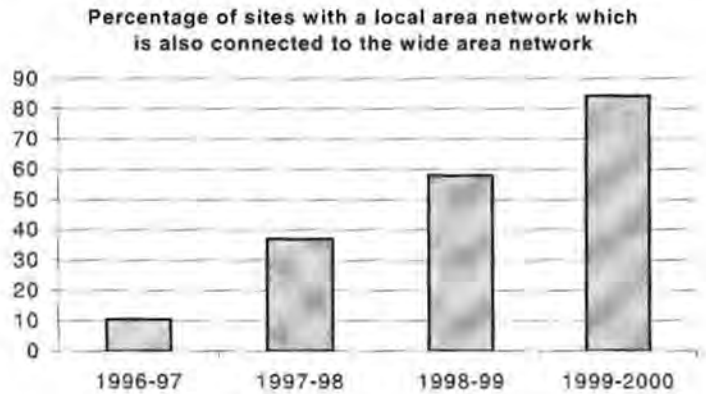


FIGURE 3: GRAPHICAL REPRESENTATION OF DATA

Although the preceding examples are excerpts from jurisdiction technology plans, schools can use the same types of performance measures to determine the value of their technology investments. It is best for a school or jurisdiction to develop its own "scorecard," as the GartnerGroup calls it, so that the measures fit the goals of the school, jurisdiction and province. The following guidelines are intended to assist staff in selecting and using effective performance measures.

Step 1: Define the school's technology goals.

Identify the goals that will form the basis of the performance measures. The U.S. Department of Education publication, *An Educator's Guide to Evaluating the Use of Technology in Schools and Classrooms*, suggests that goals fall into two broad categories: outcome and intermediate goals. (Quinones & Kirshstein, 1998). Outcome goals "reflect the final product, or outcome," whereas intermediate goals are essentially the "means to an end" <http://www.ed.gov/pubs/EdTechGuide/>. For example, if the outcome goal is improved student writing, two intermediate goals may be that students have frequent access to computers with word-processing software and that teachers participate in professional development activities to learn how to use technology effectively to teach writing.

Be sure that the school's goals are consistent with provincial and jurisdiction priorities. For example, one of the required areas for improvement during the school years 2001/02 to 2003/04 is improving access to information technology. This priority is related to goals one and three of Alberta Learning's three-year plan and must be addressed by all schools and jurisdictions (*Guide for School Board Planning and Results Reporting, 2001*) <http://www.learning.gov.ab.ca/department/planning/SchoolGuides/SchBdGuide/>.

Goal One: High quality learning opportunities

Outcome: The learning system is flexible and provides a variety of programs and modes of delivery.

Goal Three: Well-prepared learners for lifelong learning, world of work and citizenship

Outcomes: Albertans are able to learn continuously. Learners are prepared for work.

Measures: Percentage of students and parents who report school helps improve students' computing skills. Student-instructional computer ratio

Step 2: Select a few of the best measures.

The GartnerGroup suggests that it is "important to have a broad, balanced set of measures covering several aspects of the enterprise." (Why Measure IT?, 1999).

Begin by listing all the possible measures for each goal, including both qualitative and quantitative measures. The functionality of the network, for example, can be quantified using "counts" such as the time it takes to download a file, the number of classrooms with network connections and the amount of storage space allocated to each student. The percentage of students who are satisfied with the speed of the network can be measured by administering a survey. Qualitative strategies can include interviewing people, conducting a focus group or summarizing the complaints handled by the help desk.

Examples of survey questions that can be used to determine the satisfaction of staff and students in relation to the TCO cost categories are provided in Appendix C.

Do not limit the measures to those that are easily measured using quantitative data. For example, the quality of computer use may be evaluated by observing how computers are used, reviewing an inventory of software, conducting interviews with teachers and examining student assignments.

Select measures that are valid and credible. It would be wrong to use increased scores on student achievement tests, for example, because the complexity of the teaching and learning environment makes it difficult to isolate technology as a variable. Access to technology may increase student motivation, which in turn may result in assignments being completed. As a result, students may earn higher marks. Attributing this sort of third-order effect to technology is difficult, however, and should be avoided.

Select measures that are simple, efficient and practical, but not simplistic. The student-to-computer ratio, for example, is one indicator of reasonable access that is simple to calculate, but it may not reflect true value if the computers are old and unreliable, or inaccessible because of where they are located or how computer time is scheduled.

Select measures that are meaningful for the intended audience. Different stakeholders, such as teachers, administrators, school board members, parents, government officials and taxpayers, want to know different things. Decide what the audience would consider to be evidence that the goals have been achieved.

Step 3: Collect data, summarize and draw conclusions.

Use the measures to collect the data and summarize it. The data will be easier to understand if you use a variety of written and visual formats such as graphs, tables, models, graphics, bulleted lists and descriptive paragraphs.

Examine the data summaries and draw conclusions about how well the goals have been achieved and which areas need improvement.

There are a couple of phenomena that may explain unexpected results. For example, increasing expectations may lead to a decrease in satisfaction even when all other indicators are positive. As teachers become more skilled in using technology, they may become dissatisfied with the amount of computer access their students have. Students who have access to new technology at home may be reluctant to use older computers at school. As the network is enhanced, there may be an expectation that large files will load more quickly, or that individuals will have more server storage space.

Another factor that may account for unexpected results is the adoption curve. It is not unusual for staff to report that technology is taking more time and is more difficult than before new computers or a new application were introduced. This phenomenon, called the "implementation dip," involves a temporary drop in productivity.

Finally, make a judgment about how much value the school is getting for its investment in technology. Ultimately, this is a subjective decision based on the evidence provided by the measures.

Rating Scale

The rating scale method of determining value is a self-assessment process consisting of criteria that result in a rating. The rating scale can be used to compare the value of the technology investment in one school to an ideal or standard or to compare value across schools based on a common set of indicators.

The Interactive StaR Chart is an example of a rating scale developed by the CEO Forum <http://www.ceoforum.org>. By answering 21 questions online, the school is rated with respect to four school profiles ranging from the Low Tech school to the Target Tech school. The questions include measures such as the number of computers, the quality of the network, the skills of teachers and the time it takes to receive technical support. The StaR Chart uses a multiple-choice format as shown in Question 1.

> Question 1—How many students per instructional computer?
>
> a) More than 10
>
> b) 10 or less
>
> c) 5 or less
>
> d) 1 student per instructional computer

The North Central Regional Educational Laboratory (NCREL) provides another online rating scale that includes indicators of engaged learning and indicators of high performance technology <http://www.ncrtec.org/capacity/profile/profwww.htm>. The technology indicators in the Learning with Technology Profile Tool are related to access, operability, organization, engagability, ease of use and functionality.

The NCREL Tool uses a multiple-choice format as shown in the following indicator.

Indicator—Diverse Tools

Students have opportunities to use a wide range of generic and context-specific tools.

a) Technology is not available.

b) Students use a single tool; e.g., a word processor.

c) Students use a few basic tools; e.g., word processors and databases, but no context-specific tools.

d) Students use a variety of basic tools such as databases, spreadsheets and word processors, as well as context-specific tools (like the use of sonar for oceanographic research).

NCREL also provides another rating scale in the *Technology Connections for School Improvement—Planners' Handbook* (McNabb & Valdez, 1999) <http://www.ncrel.org/tplan/handbook/toolkt13.htm>.

The Technology Evaluation Rubric uses a four-point scale and includes indicators such as vision, curriculum integration, professional development, infrastructure and funding. The following excerpt from the rubric is similar to the previous examples, except in format, because in all cases a continuum of value has been defined.

Curriculum Integration	*1*	*2*	*3*	*4*
Lesson Integration Levels of Use Frequency of Use	One or more of the following are in evidence: • Technology is used as a reward for finished work. • Students use technology to practice things they already know. • Technology use is rare.	One or more of the following are in evidence: • Technology is sometimes used to support a lesson. • Students use technology for supplemental learning. • Technology is used an average of once a month.	One or more of the following are in evidence: • Teachers often consider some technology tools when planning lessons. • Students' technology use includes information gathering, organizing and publishing in a variety of media. • Technology is used weekly.	One or more of the following are in evidence: • Teachers consider a variety of technology tools when planning. • Students use technology for information gathering, organizing and multimedia publishing. • Technology use is part of daily classroom routines.

FIGURE 4: EXCERPT FROM TECHNOLOGY EVALUATION RUBRIC, NCREL

In *Technology in American Schools: Seven Dimensions of Progress* (Lemke and Coughlin, 1998), the Milken Family Foundation also uses a rubric format and, in their words, provides "the right questions to be asking" <http://www.mff.org/edtech/>. A detailed rubric for one of the dimensions, Professional Competency, is available at their web site. It includes a rating scale based on three stages of progress: Entry, Adaptation and Transformation.

Stage I—Entry	*Stage II—Adaptation*	*Stage III—Transformation*
At this stage, educators, students and the community are aware of the possibilities that technology holds for improving learning—but learning, teaching and the system remain relatively unchanged. Educators at this level lack access to technology and the requisite skills to implement and sustain significant changes in practice.	Technology is thoroughly integrated into the classroom in support of existing practice. Educators at this stage have developed skills related to the use of technology, but have primarily applied these skills to automate, accelerate and enhance the teaching and learning strategies already in place.	At this stage, technology is a catalyst for significant changes in learning practice. Students and teachers adopt new roles and relationships. New learning opportunities are possible through the creative application of technology to the entire school community.

FIGURE 5: STAGES OF PROGRESS, MILKEN FAMILY FOUNDATION

One Alberta school jurisdiction (Edmonton School District No. 7) defines similar profiles in its district technology plan, rating schools as Level 1 to Level 4 in terms of the stages of evolution that they go through as technology is implemented. Figure 6 shows one of the indicators used in the profile—PD and training. There are seven indicators in total: planning and leadership; infrastructure; technical support; professional development and training; student access and use; teacher access and use; and the role of non-teaching staff.

Category	*Stage 1*	*Stage 2*	*Stage 3*	*Stage 4*
PD and Training	Other professional development needs take priority over technology. One or two teachers attend district workshops, conferences and external training courses.	One PD day is devoted to technology annually. A few staff make technology upgrading a personal priority and they attend workshops, conferences and external training courses. The focus of PD is on hardware and software skills.	PD is provided coincidentally with technology change. The focus of PD is on technology integration. The majority of staff make technology upgrading a personal priority.	PD is an integral part of the school's technology plan. The focus of PD is on transforming learning and teaching with technology.

FIGURE 6: STAGES OF EVOLUTION IN IMPLEMENTING TECHNOLOGY, EDMONTON SCHOOL DISTRICT NO. 7

All of these examples of rating scales have things in common. Measures, questions or criteria are used to describe certain aspects of the implementation of technology. A continuum of quality or progress is defined for each measure using a three- or four-point scale that describes typical or ideal scenarios. By assigning a score to each response, educators can derive a total score. In all cases, the indicators and the items in the continuum reflect the subjective views of the authors. Therefore, it is important to select a rating scale that is consistent with the values, beliefs, opinions and goals of the staff in the school.

Following is an example of a rating scale developed by contributors to this document to assist Alberta schools in determining the value of their technology investment. The indicators and descriptors in the rating scale were reviewed by a panel of educators from across Alberta and tested with the schools that conducted the case studies. (See Appendix D).

The following goals were used as the foundation of the instrument:

- All students will have the knowledge, skills and attitudes that they need to use Information and Communication Technology, as articulated in the Program of Studies.

- All students, including students with special needs, will have reasonable access to a wide variety of high-quality resources in a technology-rich learning environment.
- All teachers and other staff will have reasonable access to appropriate resources in a technology-rich teaching and work environment.

The rating scale includes seven categories of value. The first is a global category about Student Learning. The other six are the cost categories used in the TCO instrument in Appendix A—Hardware, Resources, Infrastructure, Technology Support, Professional Development, and Management and Planning. The indicators are examples of the type of evidence that can be used to judge value as defined by the goals. For convenience, all of the indicators used in the rating scale are listed below.

Student Learning

Students learn to use technology in a variety of contexts and subjects. They also use technology in a variety of ways to enhance student learning. Value is measured in terms of the number, range and quality of opportunities that students have to use and apply technology.

Indicators:

- Quality of opportunities students have to use technology across the curriculum.
- Range of opportunities students have to learn to use and apply technology.
- Number of students who have the knowledge, skills and attitudes defined in the Information and Communication Technology (ICT) Program of Studies.

Hardware

Hardware refers to the computer equipment and peripheral devices used by students and staff. For example, hardware includes CPUs, disk drives, monitors, keyboards, printers and projectors. Value is measured in terms of reasonable access to the hardware for students and staff. Reasonable access is more than just the number of computers in the school, however. It also depends on where the computers are located and when they are available for students and staff to use.

Indicators:

- Number of computers for students.
- Locations of computers.
- When computers are available for students to use.
- Age of work stations.
- Level of access that students with special needs have to specialized technologies that help them to learn.
- Level of access to computers that teachers have.

Resources

Resources are the software, applications, content, Internet subscriptions and consumable supplies used by students and staff. Resources also include print materials, such as textbooks and manuals, used by students and staff to learn how to use technology. Value is measured in terms of the number, quality and variety of resources that are available to students and staff.

Indicators:

- Range of technology-based learning resources for students.
- Range of technology tools for teachers.

Infrastructure

Infrastructure includes all components that are provided in the school building to make it possible to add computer work stations to the network, which consists of the school's local area network, the jurisdiction's wide area network and the Internet. Value is measured in terms of the speed and functionality of the network, as well as the locations where it can be accessed.

Indicators:

- Speed of the school's network.
- School's WAN connection.
- Level of security of the school's network.
- Level of access to the Internet for students.
- Amount of staff access to e-mail.

Technology Support

Technology support is the service provided by school staff, jurisdiction staff, vendors or third-party contractors to keep the hardware, software and infrastructure functioning effectively and efficiently. Value is measured in terms of the reliability and quality of the support.

Indicators:

- Reliability of work stations.
- Reliability of the network.
- Timeliness of technology support.

Professional Development

Professional development (PD) refers to activities that are used to assist teachers, support staff, administrators and other staff in learning to use technology effectively and efficiently. Value cannot simply be measured in terms of the opportunities that staff have to participate in PD activities. It must also be measured in relation to the intent, which is to increase the expertise of staff.

Indicators:

- Number of staff that have the foundation skills to use technology effectively and efficiently.
- Level of staff understanding and expertise related to security issues.
- Level of teacher expertise in using technology for teaching.
- Level of teacher expertise in using technology for student learning.

Management and Planning

Management and planning includes budget planning for technology as well as the management of technology infrastructure, hardware and resources. Value is measured in terms of the results and the quality of the planning and management processes that are used.

Indicators:

- Quality of technology planning.
- Efficiency of the organization of technology resources.
- Level of staff involvement in making decisions about technology goals, expenditures and implementation.
- Role of the principal in providing leadership related to technology.

The rating scale provides four descriptors of quality for each indicator, ranking each according to a stage of implementation—early, emerging, mature and advanced. The scale describes a continuum of evolution; the desired state, or target, is the mature stage.

The purpose of the rating scale is to provide schools with a sample as a starting point for identifying whether they are investing appropriately in each of the six cost categories. Although it can be used as it is, it is best to revise the rating scale to suit local needs and goals. If a number of schools use the same rating scale, it may be possible to use the results to compare value among schools with similar demographics, characteristics and goals.

Key Messages in Chapter Two

- The second stage in a TCO analysis is to collect data about the value derived from the investment so that value can be compared to costs.
- Value is defined in terms of goals.
- The performance measure method of determining value consists of identifying measures based on the goals established by the school in its technology plan.
- A rating scale can be used to compare the value of the technology investment in one school to an ideal or standard or to compare value across schools based on a common set of indicators.

CHAPTER THREE
MINIMIZING THE COST OF TECHNOLOGY

"Was this huge expenditure justified? Is it all necessary? Most companies seem to have substituted serendipity for management practices, which has resulted in a massive waste of time, effort and money, and undermines the real benefits of these systems."

— GartnerGroup, 1996

Strategies to Control Costs

Once the cost of technology has been compared to the value of the investment, it may be tempting to conclude that everything is fine, or that the costs are too high and the budget should be cut. It is premature to jump to a conclusion, however, until a few more questions have been answered. Is everything possible being done to keep costs down? Are some decisions or practices contributing to increased costs? What key strategies can be implemented to reduce the total cost of technology?

Schools will always be faced with the challenge of scarce resources. The goal, according to the GartnerGroup, is to balance efficiency and effectiveness. The previous chapter about value focused on effectiveness, which is "doing the right things" or using the resources to enable the school to achieve its goals. This chapter will focus on efficiency, which is "doing things right" or getting the most out of the resources you have.

A great deal is known about how to minimize the cost of technology. Even though most of the strategies identified by organizations such as the GartnerGroup and Microsoft apply to business and industry, the same general strategies apply to education. This chapter "translates" these big ideas into the culture and context of the school.

Four general strategies are highlighted in this document, with several specific strategies described for each one.

General Strategies:

1. Plan and manage.
2. Reduce complexity.
3. Increase reliability.
4. Provide user support.

These strategies provide practical suggestions that do not require specialized technologies or processes. It is wise to be skeptical of IT vendors and companies that promise to reduce TCO by using their products or consultants.

If the goal is to reduce the amount spent on technology, the worst strategy is just to cut the budget. This is likely to result in a shift in costs, not a reduction. It is also likely to result in a drop in value. For example, a decision not to replace aging work stations may result in increased repairs and a decrease in use by students and teachers. By understanding the strategies that can be used to control costs, decisions or practices that may be contributing to increased costs can be identified. Many of the strategies will also reduce unbudgeted and indirect expenses such as downtime, informal technical support among users and time spent in

unproductive activities such as searching for documents. To reduce costs, the right people need to be doing the right things in the right way with the right technology.

Cost-control Strategy No. 1: Plan and manage.

Implement cost-saving strategies as part of a holistic, long-term technology plan, not as a quick fix for problems. In the absence of a plan, the school may invest in technologies that are quickly outdated, for which there is no support, or that are not compatible with those in other schools or with the jurisdiction infrastructure. Lack of planning may also result in unnecessary purchases or in unexpected expenses that could have been foreseen. Without a plan, it is difficult to budget effectively for technology.

Planning is an ongoing process that involves constant course corrections based on managing the technology assets and monitoring decisions, actions and expenses. Without strategies to plan and manage the school's technology, opportunities to save may be missed and unexpected expenses remain unchecked.

The planning model in Figure 7 depicts three stages in an ongoing cycle—plan, implement and manage. It is based on an IT lifecycle proposed by Microsoft and has been mapped onto the evergreen cycle described in Chapter One.

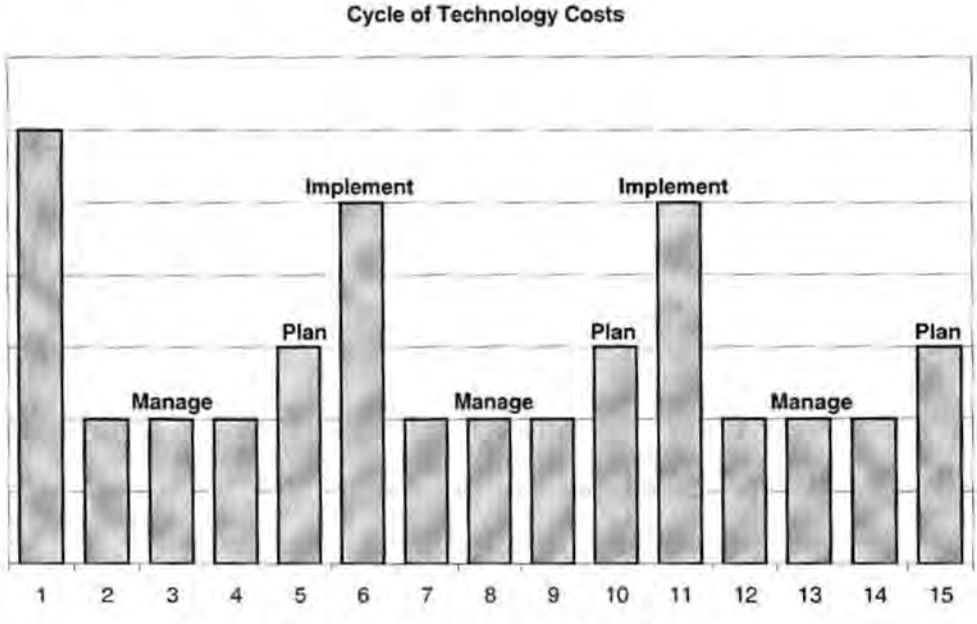


FIGURE 7: PLANNING CYCLE FOR TECHNOLOGY

Specific strategies to be considered:

1. Understand the big picture.

   The best way to minimize the cost of technology is to do the right things in the right way. Therefore, if school technology plans are consistent with provincial and jurisdiction plans, requirements, initiatives and standards, the schools are more likely to derive maximum benefit from software licensing initiatives, infrastructure upgrade projects, professional development programs and technology support services.

Long-range planning should take into account changes in technology that are about to happen. Technology does not change as rapidly as many people believe. There is always advance notice about impending changes, from big things such as the Internet to small changes such as the next version of an operating system. To understand the big picture, educators need to pay attention to the trends as reported in product announcements, trade journals and media reports.

2. Involve IT professionals in planning.

   The computing environment in schools is becoming more and more complex, especially as all devices, schools and jurisdictions become networked together and connected to the Internet. It is no longer reasonable to expect principals and teachers to have the technical expertise to make all of the technology decisions related to the school.

   Schools should involve jurisdiction IT professionals in planning, implementing and managing their technology. IT staff can also assist the school in understanding and exploring the potential impact of new technologies such as video streaming and new ways of doing things such as online resource repositories. IT professionals are trained in systems design and may be able to save the school time and money, for example, by identifying how one change in the school network could cause a chain reaction of other effects.

3. Focus on the essentials.

   "Why do we need this?" is the most important question to ask when a purchase is being contemplated. The curriculum demands a basic level of technology, such as multimedia computer systems with a standard suite of applications and access to the Internet. Other technologies, such as digital cameras, scanners, DVD drives, broadband networks and e-mail for all students, can be used effectively to enhance learning but are not actually required. The trade-off with this strategy is that teachers may be dissatisfied with these limitations.

4. Make purchases in accordance with the school technology plan.

   Make all purchases as a result of a well-articulated technology plan that includes details about the budget for technology. If all staff have input to the plan and understand how purchases are made, unexpected expenses should be rare. Schools should stick to the evergreen plan established in the technology plan.

   In larger schools with several departments, have a central committee or administrator approve all technology purchases to ensure that they comply with the school's infrastructure and technology standards.

5. Avoid the leading edge.

   Be cautious about purchasing the latest new device and participating in innovative projects. While there is value in trying new things, there is also cost. Try to ensure that the school technology plan drives decisions, not the latest marketing promotion.

6. Create an infrastructure that positions the school for the future.

   Ensure that all classrooms, offices, labs and other locations such as the library have enough network connections and electrical outlets to accommodate multiple computer stations. This infrastructure will suit the school's needs for at least the next decade, and it is generally more cost effective to wire the school all at one time rather than extending the network piece by piece.

7. Piggyback on other initiatives.

   Each year many priorities, projects and changes compete for the school's time, money and other resources. Technology implementation is more efficient and cost effective when done in conjunction with these initiatives. For example, the Alberta Initiative for School Improvement (AISI) provided many schools with the opportunity to incorporate technology into innovative and creative projects to improve student learning.

   Recent changes to the English language arts curriculum have included new learning outcomes related to technology. At the same time, a new cross-curricular Program of Studies for Information and Communication Technology (ICT) has been introduced. It is more efficient and effective to provide professional development that is focused on the overlap between these two curriculum changes than to address them separately.

   Some schools have taken advantage of other capital projects such as renovations and electrical upgrades to install cable paths that can be used in the future to provide additional network connections and prepare classrooms for additional computer work stations.

8. Collaborate with other schools.

   Form a purchasing cooperative with other schools and negotiate lower prices by placing larger orders. Collaborate with other schools to plan joint professional development and training programs. Share technical support staff among schools. Take turns using specialized resources such as CD-ROMs on narrow topics, robotics kits and digital cameras.

9. Keep an inventory.

   Use an inventory of hardware components and software licences to expedite service, qualify for upgrades, plan for replacement and claim an insurance refund following a theft. Guard against loss and theft by storing original software masters, such as CD-ROMs, in a secure location.

10. Limit the use of older technology.

    Use older work stations for basic instruction such as keyboarding, or to run specialized applications such as graphing tools in mathematics. Invest as little as possible in these work stations, however. Avoid adding them to the network and be cautious about upgrades and repairs.

    As computers and peripherals in the school office are replaced, move the older systems to classrooms in the same school if they are compatible with the ones that are already being used by students.

11. Limit consumption of power and supplies.

    Turn computers off when they are not in use to conserve power. Limit the use of consumable supplies such as paper, toner cartridges and disks.

Cost-control Strategy No. 2: Reduce complexity.

In a complex computer environment with a variety of different components, products and applications, conflicts among devices and applications are more likely to occur, and it can be difficult and time-consuming to provide technical support. It is more difficult for staff and students to use the system, and they are more likely to have problems. The GartnerGroup calls this state of affairs "architectural chaos."

Reducing complexity is not necessarily achieved simply by making the system simple to use. Behind a simple user interface may be a complex network involving the integration of a variety of databases, servers and security systems.

Limiting the variations among work stations, network components and applications reduces complexity. A standardized computer environment is easier to use and costs less to install and maintain than a heterogeneous one. Although possible, a standard system is difficult to achieve in a school because of the need for a wide variety of tools and learning resources for a range of courses and topics of study.

Every computer work station added to the environment adds to its complexity. It may add to the traffic on the network, increase demand for storage space on the servers, change the usage patterns of staff and students and require additional technical support. This means that as access to technology increases in the school, the need for effective strategies to deal with complexity will also increase.

Specific strategies to be considered:

1. Standardize on a single platform.

   One of the most effective ways to minimize technology costs is to standardize on a single platform, such as PC/Windows or Macintosh, for both students and staff.

   During the migration to a single platform, cluster work stations that do not comply with the new standard together and use them for special or niche purposes. This will make it easier for staff and students to work in an environment that requires them to know more than one operating system and will make it more efficient to provide technical support.

2. Limit the differences among computer work stations.

   As much as possible, make all work stations identical in terms of brand names, model numbers, processors, operating systems and versions of the operating system. The best way to achieve this is to purchase everything at the same time from the same vendor or manufacturer and upgrade the operating system as new versions are introduced. This may not be realistic for every work station in the school but standards regarding the brand name, processor and operating system can be maintained over the long term.

3. Limit the number of software applications on each work station.

   Use one general purpose software suite, such as MS Office, AppleWorks or Corel Office, and have the same version installed at every computer work station. Each additional software application increases the complexity of the work station. Therefore, add as few applications as possible.

   In practical terms, certain limitations must be considered. For example, install one Internet browser and decide which plug-ins are actually required. Delete the games and do not install extra fonts. Select only one or two of the best encyclopedias and a few other reference works. In addition to reducing complexity, these actions will limit distractions that result in indirect costs.

4. Select applications with similar user interfaces.

   Make the user interface identical across all applications to decrease training time and the chance of user error. All of the latest applications and operating systems resemble a web browser. If older applications are used, select the ones that are most similar to the layout of the general purpose software suite.

5. Do not change the work station configuration.

   Implement a combination of technical strategies and user guidelines to maintain the work station configuration. For example, use disk imaging, or ghosting, to create identical configurations and install the same software on all work stations. The master configuration can be re-installed periodically throughout the year, if necessary.

   Set up user profiles that will reset the desktop layout and control panel settings as each user logs onto the network. Do not allow students or staff to download free programs, browser plug-ins or media players.

6. Implement a homogeneous local area network environment.

   Install a single local area network throughout the school that encompasses the classrooms, office, computer labs, library and other locations. Eliminate older peer-to-peer networks, such as those used for sharing printers or for library automation systems.

Cost-control Strategy No. 3: Increase reliability.

Unreliable work stations and networks increase the cost of technical support, contribute to indirect costs such as downtime and decrease the satisfaction of students and staff.

Specific strategies to be considered:

1. Purchase quality products.

   Purchase products that meet jurisdiction standards and that have been tested and approved by jurisdiction IT staff. Beware of low-priced systems for the home market that may contain non-standard components and that are not suitable for a school setting. Purchasing quality products will save money in repairs and technical support.

   Be cautious about accepting donated computer systems and peripherals. Ensure that they comply with jurisdiction standards and requirements.

2. Prevent technical problems.

   Keep the work stations clean and cables and cords tidy. Have a technician clean the keyboards, mice and monitors annually, and replace frayed or damaged cables.

   Prevent viruses by updating virus protection software regularly and managing the use of disks from home, for example, by setting up a cleansing work station. Educate staff about the dangers of opening e-mail attachments from unknown sources.

3. Prevent theft and vandalism.

   Unfortunately, some students deliberately damage computer systems in some schools. To increase accountability and prevent damage, assign students to the same work station each time they use one in the classroom or lab. In public areas such as the school library, consider options such as locking the computers to the desks and signing out the computer mouse in the same way as books are borrowed.

4. Protect files from loss or damage.

   Save files to a server with a data backup system. Add an uninterruptible power supply (UPS) to the server to reduce power fluctuations and to maintain power in the event of a power outage.

5. Keep a service log for each device.

   To track recurring problems and take advantage of warranty services, keep a record of repairs and technical support for each computer and peripheral device. Include the name, model and serial number of the device as well as the warranty dates. For each service incident, record the date, problem, solution, who serviced the device and the costs. The service log can also help in deciding when to stop investing in repairs for older systems.

6. Replace aging work stations.

   As computer systems age, they typically begin to need repairs and upgrades. Establish a suitable replacement or evergreen cycle, such as five years, and replace all of the work stations at the same time, if possible. Dispose of the old equipment and software.

Cost-control Strategy No. 4: Provide user support.

Providing staff and students with timely technical support to resolve problems is critical if the computer system is to be used effectively. Problems that go unresolved or take a long time to be repaired add to technology costs indirectly and reduce the value of the system. For example, staff time can be wasted as they try to resolve the problem. When a device sits waiting for repair, it puts a strain on other resources and decreases the resources available to students. Teachers who encounter frequent problems may lose confidence in the system and be reluctant to use technology with students.

There are many ways to reduce the need for support. This is particularly important in rural settings where local support is not available. Many problems can be avoided if users are skilled in using technology. Therefore, one strategy to reduce the need for support is to provide training for staff and students.

Specific strategies to be considered:

1. Provide technical support.

   Have a technical support person available regularly to resolve users' technical problems. This strategy increases user satisfaction and reduces the likelihood of further damage to the system.

   There are many ways to provide technical support—a full- or part-time position, a position shared among schools, a jurisdiction position or a contract with a third party may be suitable in your situation. It is more cost effective to have an IT professional with specialized training in the types of systems used in the school and jurisdiction to provide technical support, rather than teachers.

   Encourage technical support staff to be committed to preventing problems, not just fixing them. Decide which basic problems the students and staff can handle when the technical support person is not at the school, and train them to do this. For example, they could learn to replace toner cartridges in the printers.

2. Negotiate the most effective warranty terms.

   Depending on local circumstances, the best warranty may provide onsite service, a cache of spare parts, an extended warranty or service in the local community. For example, the warranty on new devices can usually be extended for a small annual fee, which some claim will pay for itself with a single service call. Some experts also claim that an extended warranty is equivalent to having another technician on staff in terms of the amount saved.

Be sure to record and track the warranties on all devices so that you do not pay for technical support that is covered by the warranty.

3. Call the Help Desk.

   Let staff know who to call for assistance. This may be the jurisdiction Help Desk or it may be a specialized Help Desk provided by the vendor of one of the products used in the school.

4. Identify common problems.

   Identify the most common problems encountered by staff and students and deal with them. This may include training or instituting a new process to prevent the problem from occurring.

5. Train staff in the basics.

   Most problems occur because the staff do not understand the basics—how computers work, where files are stored, how to use Help systems and simple troubleshooting techniques. Make the time to provide staff with these basic skills because it will reduce wasted time and prevent problems.

   Whenever new hardware or software is introduced to the school, provide a training program for all staff. Have new staff members participate in an orientation workshop each year.

6. Train students in the basics and appropriate use.

   Students also need to know the basics about the school's computer system. In addition, they need to know about appropriate use so that they do not jeopardize the system. Provide new students with an orientation to the system before giving them the privilege of using it.

7. Use effective professional development strategies.

   In addition to the basics, teachers need opportunities and time to learn how to use technology effectively to enhance student learning. Some research suggests that it takes about five years for teachers to fully integrate new techniques into their teaching repertoire.

   The most effective strategies are not cheap, but the cheap strategies are ultimately a waste of time and money. Professional development must be frequent and regular, directly related to what the teacher teaches, hands-on and matched to the teacher's skills.

Using the Strategies

The cost-saving strategies on the previous pages can be used as a checklist to assess what is currently being done to minimize costs. They provide a good starting point for discussing the current situation and generating ideas for improvement.

Consider the selection of strategies carefully because they are rarely neutral. For example, purchasing computer systems that comply with a strict jurisdiction standard must be weighed against a belief in the autonomy of the school. In another example, limiting the number of applications on each work station must be balanced against the teachers' desire for flexibility and autonomy in choosing instructional materials. In some cases, a strategy may need to be discarded because of unacceptable trade-offs.

The four general strategies can be used to judge an idea or a purchase request. For example, suppose that a teacher has attended a conference or workshop and wants to buy a new piece of software that students can use for mind mapping. Is this a good idea? There is the initial cost of the application, the cost of installation and the cost of technical support to change the disk image master to include the new application. Adding another application to the work

stations will increase the complexity of the system, and teachers will have to be trained to use it. The costs may be offset by the value, however, because the teachers and students will be pleased to have a new application that assists them in organizing and displaying their ideas.

Suppose that the school is considering forming a business partnership with a computer vendor that will install a new lab of computers. Which strategies would apply to this situation? Could "free" computers actually increase the cost of technology in the school?

Would it be a good idea to buy a class set of $300 portable word processors just to teach keyboarding? What questions should be asked before this decision is made?

Schools may not be able to determine exactly how much can be saved if a specific strategy is implemented. The computing environment is too complex to attribute a change to a single variable. As well, many of the strategies are inter-related and must be implemented together to be effective. However, the overall effect of cost-saving strategies can be demonstrated through a long-term analysis of TCO.

Key Messages in Chapter Three

- The third stage in a TCO analysis is to compare the school's decisions and practices to cost-saving strategies.
- There are four general strategies that can minimize the cost of technology:
  1. Plan and manage.
  2. Reduce complexity.
  3. Increase reliability.
  4. Provide user support.

CHAPTER FOUR
PLANNING FOR TECHNOLOGY

"At its most basic level, TCO can be viewed as good management practice."

— Microsoft

TCO Is Good Planning

During a TCO analysis, a lot of data and information is collected about the costs of technology, the value of the investment and to what extent cost-saving strategies are being implemented. It is not the data that is important but what is done with it, however. What does this data mean? What should be done to improve the effectiveness and efficiency of technology in the school? What can be learned by conducting an analysis of the total cost of ownership of technology?

Understanding TCO is a step forward in the evolution of effective technology planning in schools and jurisdictions. In the beginning, most technology plans were simply purchase orders for hardware and software. Recently, technology plans have contained a more detailed rationale for purchases and actions that includes a vision, goals, action plans and a budget. Now, it is time to adopt the principles of TCO and to recognize that technology planning is a process that does not stop with the written plan but continues into implementation and includes managing the resources and reviewing progress. Throughout, data is collected and judgments are made.

Stakeholders will continue to express concerns about the cost of technology until a change of thinking occurs. Technology is not an optional add-on to the programs or the business functions of a school. It is as important to a well-run school as teachers and textbooks and therefore must become an integral part of the planning processes that are already used in schools. This means that the school principal must take a leadership role, and that educators and stakeholders must view technology as an enabler that supports the educational goals of the school. The GartnerGroup suggests that the focus needs to shift from total cost of ownership to effective cost of ownership.

The lessons learned from this study of TCO have been applied to the two technology planning processes described in this chapter. The first is a TCO improvement project, which is suitable for planning and implementing a short-term project designed specifically to reduce the costs of technology. The second process is school technology planning, which infuses technology planning into the three-year planning cycle of the school.

TCO Improvement Project

It may be wise to begin tackling some of the issues related to TCO by focusing on a short-term project that will achieve immediate results. The GartnerGroup suggests that an organization begin by "stabilizing the environment"; in other words, identifying the most important factors that are contributing to costs and then doing something about it.

The TCO improvement process consists of four steps:

1. Understand the problem.
2. Make a plan.
3. Carry out the plan.
4. Review the results and strategies.

This process is similar to two others that are familiar to educators, the mathematical problem-solving process and the action research process. The mathematical problem-solving process attributed to George Polya consists of essentially the same four steps, although in Polya's model the fourth step is called "looking back." The action research process also involves four stages that are cyclical: observing, reflecting, planning and acting. For example, a teacher may begin an action research project by observing student behaviour and collecting data to identify areas for improvement. Next, the teacher analyzes the data, thinks about what it means and makes a plan to try a specific strategy. Then the strategy is implemented, and the teacher observes and collects more data to examine the impact of the intervention. Each loop through the cycle results in increased understanding and improved teaching strategies.

A TCO improvement project is similar because it involves collecting data about a problem, making a plan to deal with it, implementing the plan and reviewing the success of the project.

Step 1: Understand the Problem.

Planning is critical because it is important to do the right things in the right way. Without it, there is the danger of misdiagnosing the problem or of treating the symptoms and not the disease.

Begin by establishing a project team that represents the stakeholders in the problem and those who provide services to support technology in the school. Have this team define what is known about the problem and identify other data that needs to be collected. The TCO analysis described in the first three chapters of this manual is a good starting point.

Engage the team in a discussion to make sense of the data. Keep it simple and efficient by collecting just enough data from multiple sources to provide good information but not so much that it becomes confusing. The process of analyzing the data should not be complex either. The purpose of the discussion is to use the data to identify problems and the strategies that may be effective in solving them.

Step 2: Make a Plan.

Use systems thinking to develop a plan to resolve the problem. Map out a strategy that accounts for all six TCO categories and anticipates the effect of a single change on other aspects of the technology environment.

Define each aspect of the plan in terms of who will do what, by when, with what resources and to what level of quality. In addition to school staff, the plan may involve staff from the jurisdiction central office or local IT companies.

Step 3: Carry Out the Plan.

During the implementation phase of the project, monitor timelines and budgets. Watch for unexpected effects of the improvement project and deal with them as early as possible.

Step 4: Review Results and Strategies.

When the improvement project has been completed, have the project team look back at the results and strategies to determine how successful it has been. Review what has been learned and identify additional things that need to be done. Consider the project as the first cycle in a process of continuous improvement.

Throughout the process, communication with stakeholders is essential. They should understand what changes are being considered and why those changes are necessary. If the project will temporarily disrupt their use of technology, they need to know for how long and in what ways. What can they do to help during the resolution of the problem? A few minutes at a staff meeting can be used to gather meaningful input, dispel fears and garner support for the changes.

School Technology Planning

In the long term, TCO can be controlled through a continuous process of planning for technology, implementing it, managing it, and reviewing efforts, costs and results. The planning model proposed in Figure 8 describes a new process for school technology planning. The discussion that follows is a brief summary of the process in terms of the total cost of ownership of technology. A detailed technology planning guide is provided on the Alberta Learning web site <http://www.learning.gov.ab.ca/technology/planninghandbook/>.

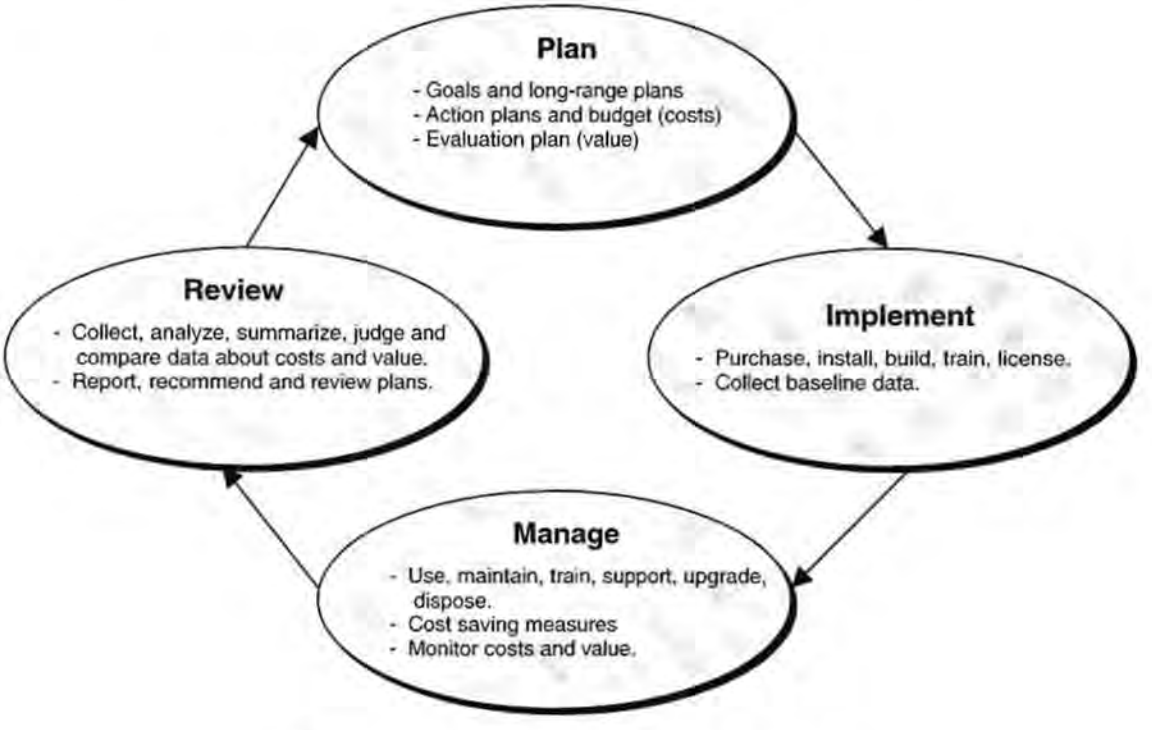

Plan
- Goals and long-range plans
- Action plans and budget (costs)
- Evaluation plan (value)
Implement
- Purchase, install, build, train, license.
- Collect baseline data.
Manage
- Use, maintain, train, support, upgrade, dispose.
- Cost saving measures
- Monitor costs and value.
Review
- Collect, analyze, summarize, judge and compare data about costs and value.
- Report, recommend and review plans.

FIGURE 8: SCHOOL TECHNOLOGY PLANNING

Plan

An effective technology plan is embedded in the long-range and annual plans of the school and jurisdiction. As described in Chapter Two, the vision and goals for technology should be focused on learning and teaching and should not be separate from the vision and goals for the school. Unfortunately, technology decisions are often based on the amount of funding available as opposed to what it will cost to achieve the goals.

Consider technology spending as a proportion of the total funding provided to the school. The GartnerGroup reports that IT spending in most businesses is about four percent of revenue. In schools, the cost per student and the cost per computer are numbers that would be useful in planning and budgeting. To arrive at these numbers, however, additional case studies must be undertaken.

The budget plan should account for all TCO categories—hardware, resources, infrastructure, technical support, professional development, and management and planning. The TCO spreadsheet in this document can be used to create the budget plan. The spreadsheet can be downloaded from the Alberta Learning web site <http://www.learning.gov.ab.ca/technology/bestpractices/tco/tcospreadsheet.xls>. Two planning scenarios are provided as examples. (See Appendix E).

Decisions about technology should be driven by data. To this end, conduct a TCO analysis at least once every three years.

Make plans that are consistent with changes that are occurring beyond the school. For example, jurisdiction standards may have changed and new services may be available. Provincial initiatives, such as curriculum changes and improved access to the Internet, may affect technology plans. Industry innovations, such as application service providers and wireless networking, may provide new opportunities and solutions to deal with technology challenges.

During the planning stage, select indicators to measure how successful the technology implementation efforts have been. Set reasonable targets that can be measured as well as a date for achieving the target. Goals that will take a long time to achieve will be more attainable if targets are set and adjusted over shorter terms, such as semesters or school years.

Implement

Collect baseline data early in the implementation stage. Baseline data is used for comparison purposes during the annual review and at the end of the three-year planning cycle. It may include the number of computers for student use, a rating of staff skills, and the current satisfaction of teachers, students and parents.

Make purchases, install hardware, build the infrastructure, train the teachers and students and license the software according to the best practices related to TCO.

Manage

Manage the technology assets using the cost-saving strategies related to TCO. Adjust strategies as necessary to adapt to the changing patterns of use in the school as staff improve their skills, applications are upgraded and the load on the network changes. Monitor costs and value.

Review

Collect summative data, compare it to the goals and action plans, and make judgments about the contribution that the technology is making to the achievement of the school's goals. Make recommendations about changes to the school's long-term and annual plans that could improve the implementation of technology.

Include technology efforts in the annual results reporting to parents and the community so that they understand how the school has used its resources for technology.

How Much Is Enough?

Many factors contribute to the difficulty of answering the question, "How much is enough to cover the costs of technology in schools?" Ultimately, schools and jurisdictions must determine the answer for themselves because it depends on what they are trying to achieve, the current level of use and the choices they have made in implementing technology.

Key Messages in Chapter Four

- Understanding TCO is a step forward in the evolution of effective technology planning in schools and jurisdictions. It is about cost-effective ownership, not the total cost of ownership.
- A short-term TCO improvement project can be planned to reduce the costs of technology.
- Technology planning should be infused into the three-year planning cycle of the school and jurisdiction.

BIBLIOGRAPHY

Economic Analysis of the Impact of IT—An Introduction to the REJ (Rapid Economic Justification) Framework. (January 2000) Microsoft TechNet. Retrieved August 3, 2000 from the World Wide Web: <http://www.microsoft.com/TCO/rejbrief.asp>.

Guide for School Board Planning and Results Reporting. (February 2001) Alberta Learning. Retrieved February 2001 from the World Wide Web: <http://www.learning.gov.ab.ca/department/planning/SchoolGuides/SchBdGuide/>.

How Technology Managers Are Lowering TCO: The Gartner TCO Model. (n.d.) Microsoft. Retrieved July 21, 1999 from the World Wide Web: <http://www.microsoft.com/education/k12/technical/solution/tco/page2.htm>.

Learning with Technology Profile Tool. (n.d.) North Central Regional Educational Laboratory. Retrieved February 13, 2001 from the World Wide Web: <http://www.ncrtec.org/capacity/profile/profwww.htm>.

Lowering Total Costs in Education. (n.d.) Microsoft. Retrieved July 21, 1999 from the World Wide Web: <http://www.microsoft.com/Education/planning/implement/tco/default_sch.asp>.

School Technology and Readiness (STaR) Chart. (n.d.) CEO Forum. Retrieved February 13, 2001 from the World Wide Web: <http://www.ceoforum.org/starchart.cfm>.

Staffing for Technology Support. Technology in Arizona: A K-12 Perspective. (October 1997) Retrieved February 23, 2000 from the World Wide Web: <http://www.aztea.org/resources/whitepaper/staffing.htm>.

Taking TCO to the Classroom. (June 1999) Consortium for School Networking. Retrieved May 14, 2001 from the World Wide Web: <http://www.cosn.org/tco/>.

The MS TCO Model: Applying the MS Solutions Framework to Reduce TCO. (n.d.) Microsoft. Retrieved March 4, 2000 from the World Wide Web: <http://www.microsoft.com/TechNet/Analpin/TCO.asp>.

Understanding the Total Cost and Value of Integrating Technology in Schools. (n.d.) Apple. Retrieved August 21, 1999 from the World Wide Web: <http://www.apple.com/education/k12/leadership/LSWTF/IDC1.html>.

What Is The Best Way to Use TCO? (1999) GartnerGroup.

What Is the Role of TCO in IT and Business Management? (1999) GartnerGroup.

What Is Your School District's Total Cost of Ownership Type? (June 1999) Consortium for School Networking. Retrieved May 14, 2001 from the World Wide Web: <http://www.cosn.org/tco/>.

Why Measure IT? (1999) GartnerGroup.

Apfel, A. (January 2000) *ASPs: Myths and Realities.* GartnerGroup.

Apfel, A. and R. Terdiman. (January 2000) *Choosing an ASP: Understanding the Links and Layers.* GartnerGroup.

Coleman, Alden T. (1998) *Lowering the Total Cost of Ownership (TCO) for the Desktop.* Retrieved February 28, 2001 from the World Wide Web: <http://www.educause.edu/ir/library/html/cnc9807/cnc9807.html>.

Dec, K. et al. (July 1996) *Management Solutions for the Distributed Computing Revolution.* GartnerGroup. Retrieved March 2, 2000 from the World Wide Web: <http://gartner5.gartnerweb.com/public/static/software/rn/00030474.html>.

Fitzgerald, Sara. (September 1999) *Technology's Real Costs—Protect Your Investment with Total Cost of Ownership.* Electronic School.

Heinecke, Walter F. and Laura Blasi, Natalie Milman, Lisa Washington. *New Directions in the Evaluation of the Effectiveness of Educational Technology.* Retrieved February 13, 2001 from the World Wide Web: <http://www.ed.gov/Technology/TechConf/1999/whitepapers/paper8.html>.

Kurkowski, Cynthia. (August 1997) *Determining the Total Cost of NC Ownership: How to Start.* NC World. Retrieved April 11, 2000 from the World Wide Web: <http://www.ncworldmag.com/ncw-08-1997/ncw-08-tco.html>.

Lemke, Cheryl and Edward Coughlin. (1998) *Technology in American Schools: Seven Dimensions for Gauging Progress.* Milken Family Foundation. Retrieved May 14, 2001 from the World Wide Web: <http://www.mff.org/publications/publications.taf?page=158>.

Mayor, Tracy. (May 1, 2000) *Value Made Visible.* CIO Magazine. Retrieved May 14, 2001 from the World Wide Web: <http://www.cio.com/archive/050100_method.html>.

McKenzie, Jamie. (November 1999) *Network Starvation.* Retrieved February 11, 2000 from the World Wide Web: <http://fno.org/feb2000/starvation.html>.

McNabb, Mary and Mark Hawkes, Ullik Rouk. (1999) *Critical Issues in Evaluating the Effectiveness of Technology.* Retrieved May 14, 2001 from the World Wide Web: <http://www.ed.gov/Technology/TechConf/1999/confsum.html>.

McNabb, Mary L. and Gilbert Valdez, Jeri Nowakowski, and Mark Hawkes. (1999) *Technology Connections for School Improvement: Planners' Handbook.* North Central Regional Educational Laboratory. Retrieved February 2, 2001 from the World Wide Web: <http://www.ncrel.org/tplan/tplanB.htm>.

Moskowitz, Steven. (March 2001) *Technology Management—Twelve Steps to Trimming Your TCO.* eSchool News Online. Retrieved March 6, 2001 from the World Wide Web: <http://eschoolnews.com/reports/management/>.

Nelson, Gerry. (November 1998) *TCO: The Next Generation.* Retrieved March 4, 2000 from the World Wide Web: <http://www.as.ibm.com/asus/thenextg.html>.

Pastor, Richard. (May 1, 2000) *Noodling Numbers.* CIO Magazine. Retrieved May 14, 2001 from the World Wide Web: <http://www.cio.com/archive/050100_advice.html>.

Pender, Lee. (2001) *How to Communicate Value.* CIO Magazine. Retrieved February 6, 2001 from the World Wide Web: <http://www2.cio.com/archive/010101_value_content.html>.

Pereus, Steven C. (March 2001) *The Next Step—Managing your district's technology operations.* Electronic School. Retrieved May 14, 2001 from the World Wide Web: <http://www.electronic-school.com/2001/03/0301f2.html>.

Quinones, Sherri and Rita Kirshstein. (1998) *An Educator's Guide to Evaluating the Use of Technology in Schools and Classrooms.* U.S. Department of Education, Office of Educational Technology. Retrieved May 14, 2001 from the World Wide Web: <http://www.ed.gov/pubs/EdTechGuide/>.

Schindler, John. (June 1997) *Managing Total Cost of Ownership in the Enterprise.* Microsoft TechNet. Retrieved May 14, 2001 from the World Wide Web: <http://www.microsoft.com/TechNet/winnt/winntas/prodfact/ent325.asp>.

Silver, M. (November 1997) *Gartner Group's 1997 PC/LAN TCO Model—The Basics.* GartnerGroup. Retrieved March 2, 2000 from the World Wide Web: <http://gartner5.gartnerweb.com/gg/purchase/0/00/531/83/doc/00053183/00053183.html>.

Stix, Andi. (1997) *Creating Rubrics through Negotiable Contracting and Assessment.* Interactive Classroom. Retrieved May 14, 2001 from the World Wide Web: <http://www.interactiveclassroom.com/articles_006.htm>.

Sustar, Lee. (2000) *Mapping the Total Cost of Ownership in K-12 Education.* Microsoft in Education. Retrieved March 4, 2000 from the World Wide Web: <http://www.microsoft.com/education/instruction/articles/tco_kernhs.asp>.

Terdiman, R. (January 2000) *ASPs: What Are the Current Marketplace Trends*? GartnerGroup.

Terdiman, R. (January 2000) *ASP Trends: The ASP Model Moves Closer to "Prime Time".* GartnerGroup.

Trotter, Andrew. (1997) *Taking Technology's Measure.* Education Week on the Web. Retrieved February 18, 2001 from the World Wide Web: <http://www.edweek.org/sreports/tc/intros/in-n.htm>.

Valdez, Gilbert et al. *Computer-Based Technology and Learning: Evolving Uses and Expectations.* North Central Regional Educational Laboratory. Retrieved January 1, 2001 from the World Wide Web: <http://www.ncrel.org/tplan/cbtl/toc.htm>.

Van Dam, Jan. (October 1999) *Total Cost of Ownership: A Business Idea That's Ready for School.* Technology & Learning.

Wheatley, Malcolm. (June 1998) *The Cutting Edge.* CIO Magazine. Retrieved April 9, 2000 from the World Wide Web: <http://www.cio.com/archive/060198_tco_print.html>.

Wheatley, Malcolm. (November 15, 2000) *Every Last Dime.* CIO Magazine. Retrieved February 6, 2001 from the World Wide Web: <http://www.cio.com/archive/111500_dime_content.html>.

APPENDIX A
CALCULATING THE COSTS OF TECHNOLOGY

There are three parts to the instrument. Part A is used to collect all of the costs that can be clearly identified at the school. Part B is used to collect costs covered by central services on behalf of the school. Part C is an analysis of the costs, with answers to the key questions. Where annual costs are indicated, use data for the previous school year.

If the TCO analysis will not be used to compare data across school jurisdictions, you may delete items K, R, W, BB and GG in Part A and all of Part B.

Note: This instrument is available as a spreadsheet on the Alberta Learning web site at <http://www.learning.gov.ab.ca/technology/bestpractices/tco/tcospreadsheet.xls>.

Part A—School Costs

Completed by:

Name: _____

Position: _____

Jurisdiction: _____

General Data

School: _____

Item	Calculation	Number
Total number of full-time equivalent (FTE) students in the school, excluding home schoolers		a:
Total number of FTE staff in the school who are users of computer technology		b:
Total number of FTE computer users in the school (students and staff)	a + b	c:
Total number of computer work stations for student use that are five years old or newer (by manufacturer's date)		d:
Total number of computer work stations for staff use that are five years old or newer (by manufacturer's date), and are not shared with students		e:
Total number of computer work stations that are five years old or newer	d + e	f:
Student-to-computer ratio	a/d	g:

Describe the situation at your school in a paragraph or two; e.g., student population, urban/rural, types and locations of computers, how students and staff use computers in the school.

Category 1: Hardware

Hardware refers to the computer equipment and peripheral devices used by students and staff. For example, hardware includes CPUs, disk drives, monitors, keyboards, printers and projectors. The total annual cost is based on a depreciation period of five years.

Include all hardware that is five years old or newer, and that is in active use by both students and staff. Include all hardware that has been acquired through government funding, school fundraising or cash donations. Count computers acquired through the Computers for Schools program, but do not assign a value to them except for upgrades made by the school.

Item	Calculation	$ Amount
Computer work stations	Initial cost of all work stations five years old or newer, or, if leased, total cost over five years	A:
Computer printers	Initial cost of all printers five years old or newer	B:
Other peripherals, such as computer projection systems, scanners, digital cameras and personal digital assistants (PDAs)	Initial cost of all peripherals five years old or newer	C:
TOTAL ANNUAL COST	1/5 times (A + B + C)	**D:**

Category 2: Resources

Resources are the software, applications, Internet subscriptions and consumable supplies used by students and staff. Resources also include print materials such as textbooks and manuals that students and staff need to learn how to use technology. Resources are assumed to have a depreciation period of five years, unless they are consumable.

Limit paper costs to those directly related to the use of computer technology. For example, a master copy printed from a computer should be included but photocopies of the master should not. If documents are sent directly from computer work stations to an intelligent photocopier, attempt to differentiate between increased printing costs due to technology and the printing costs that would have occurred in the past.

Item	Calculation	$ Amount
Standard general purpose software applications on all work stations; e.g., office suite	Total amount spent, including initial cost and upgrades	E:
Technology-based learning resources, such as CD-ROMs and special purpose instructional software	Total amount spent, including initial cost and upgrades	F:
Management applications, such as a student marks program, student information system, library automation system and school-based accounting	Total amount spent, including initial cost and upgrades (school-level costs only)	G:

Print materials, such as textbooks and manuals that support the use of technology	Initial costs of all print materials that are five years old or newer	H:
Subscription services and other annual fees for resources; e.g., Electronic Library, Web Links	Total amount spent this year on licensing fees	I:
Consumable supplies, such as printer paper, toner/ink cartridges, backup tapes and disks	Total amount spent this year on consumables	J:
The school's share of costs covered by the jurisdiction on behalf of schools	Include annual costs in any of the sub-categories above.	K:
TOTAL ANNUAL COST	(1/5 E) + (1/5 F) + (1/5 G) + (1/5 H) + I + J + K	**L:**

Category 3: Infrastructure

Infrastructure includes all components that are provided in the school building to make it possible to add computer work stations to the network, which consists of the school's local area network, the jurisdiction's wide area network and the Internet. Use the average cost of $13.30 annually per computer work station and $9.50 annually per printer to calculate the cost of electrical power that can be attributed to computers. This is based on an estimate of $0.07 per day per computer and $0.05 per day per printer, and assumes that each is used about half of the time for a total of 190 days per year. (1999 rates. Source: Epcor).

The depreciation period varies from three to 15 years for the items in this category. Therefore, the final formula contains a number of fractional calculations.

Item	Calculation	$ Amount
Wired locations; i.e., drops for work stations	Total amount spent, including cable, conduit and labour (include extra electrical outlets installed for computer work stations)	M:
Network hubs, switches, routers and racks	Initial costs, including hardware and labour	N:
Network servers, including related software, resources, UPS and backup systems	Initial costs, including hardware, software and labour	O:
Monthly charges for electrical power, ISP and WAN	Total amount spent in one year on monthly charges for electrical power, Internet service and WAN (school-level costs only)	P:

Computer furniture	Total amount spent on additional furniture required to support technology in the school; e.g., computer desks, computer chairs, printer stands, projection screens and other furniture	Q:
The school's share of costs covered by the jurisdiction on behalf of schools	Annual costs in any of the sub-categories above plus shared costs of the wide area network	R:
TOTAL ANNUAL COST	(1/15 M) + (1/3 N) + (1/3 O) + P + (1/15 Q) + R	**S:**

Category 4: Technology Support

Technology support is the service provided by school staff, jurisdiction staff, vendors or third-party contractors to install the hardware, software and infrastructure and to keep it functioning effectively and efficiently. It also includes the cost of maintaining the school's web site or intranet.

Technology support includes formal technology support only, not informal support such as staff helping each other to solve problems. Include data related to technology support for all hardware, regardless of age.

Item	Calculation	$ Amount
School network operator or school technology support staff	Total amount spent per year or number of hours multiplied by average staff costs	T:
Maintenance and support contracts with third-party contractors or vendor support paid for by the school	Total amount spent per year of contracts or vendor fees	U:
Installations, repairs and upgrades of all hardware and infrastructure components, including replacements due to theft or vandalism	Costs per year	V:
The school's share of costs covered by the jurisdiction on behalf of schools	Annual cost of technology support in the school that is paid for by the jurisdiction and not by the school	W:
TOTAL ANNUAL COST	T + U + V + W	**X:**

Category 5: Professional Development

Professional development (PD) refers to activities such as training workshops that are used to help staff use technology effectively and efficiently. PD includes formal activities only, not informal activities such as staff helping each other to learn new things. Include PD for all adult users of computer systems in the school, including technology support staff and administrative support staff.

Staff salaries are not included, but the cost of supply staff to provide release time is. Therefore, school-wide PD days would not include costs for staff to attend but would include the costs of speakers, venue, materials and transportation. Do not include internal arrangements that are used to release staff from regular duties to attend PD and training activities.

Item	Calculation	$ Amount
Cost of release time for staff to attend professional development and training activities	Total number of days per year for all staff multiplied by the cost of supply staff per day	Y:
Cost of time for school-based workshop leaders to conduct professional development and training activities	Total number of hours or days per year, including preparation, presentation and follow-up, multiplied by average teacher salaries per hour or day	Z:
Cost of workshops, conferences and other PD activities provided by staff or organizations outside of the school	Total cost per year including consulting fees, registration fees, travel and expenses	AA:
The school's share of costs covered by the jurisdiction on behalf of schools	Annual cost of PD that is paid for by the jurisdiction and not by the school	BB:
TOTAL ANNUAL COST	Y + Z + AA + BB	**CC:**

Category 6: Management and Planning

Management and planning includes budget planning for technology as well as the management of technology infrastructure, hardware and resources.

Item	Calculation	$ Amount
Cost of staff time spent on technology planning activities, such as committee work	Total number of hours/days per year, including research, writing and meetings, multiplied by average staff salaries	DD:
Cost of staff time spent on managing the infrastructure, hardware and resources	Total number of hours/days per year, including ordering, recording and taking inventory, multiplied by average staff salaries	EE:
Cost of external consultants or vendors involved in technology planning with the school	Total costs per year, such as consulting fees	FF:
The school's share of costs covered by the jurisdiction on behalf of schools	Annual costs in any of the sub-categories above that are directly related to the school (not jurisdiction-level planning for technology)	GG:
TOTAL ANNUAL COST	DD + EE + FF+ GG	**HH:**

Part B—Shared Jurisdiction Costs

The purpose of Part B of the instrument is to identify costs paid for by central office rather than by the school. To draw meaningful comparisons across school jurisdictions, all costs need to be identified, regardless of "who pays." Add the data resulting from this instrument to the data provided by the school in Part A.

Since the TCO analysis is centred on the school, the general question guiding this data collection is, "How much of this central resource did the school use?" To calculate the answer, you may need to determine the total cost of the central resource and attribute a certain fraction to the school.

Category 1: Hardware

Whether the hardware has been purchased by the school or the jurisdiction's central office, include the cost of all of the hardware in the school in the three hardware sub-categories. A separate sub-category for shared jurisdiction costs has not been included.

Category 2: Resources

Management applications used directly in school offices are included in this category. The jurisdiction's financial and student information systems are included in the scope of the TCO analysis. The personnel/payroll system and other information systems unique to the school jurisdiction are not included.

Item	Calculation	$ Amount—School's Share
Cost of technology-based resources that are loaned to schools through a jurisdiction media centre	Annual fee or a share of the value of the resources that were actually used by this school	
Financial information system	Include only the costs of servers, software, licensing, programmers and related technical support. Do not include central operational staff such as data entry clerks.	
Student information system	Only the costs of servers, software, licensing, programmers and related technical support, not the cost of central operational staff such as data entry clerks	
TOTAL—SCHOOL'S SHARE		K:

Category 3: Infrastructure

Shared jurisdiction costs for infrastructure are related to all aspects of the jurisdiction's wide area network, including the wired or wireless connections among buildings. The depreciation period varies, depending on the type of connection. For fibre optics, use 25 years. For wireless dishes, use seven years. For other types of connections, indicate the depreciation period that you have applied to the calculation.

Item	Calculation	$ Amount—School's Share
Wide Area Network (WAN)	Include related hardware, applications, fees, licensing and staff salaries. Include all wired or wireless connections among buildings. Include e-mail, Internet, security, monitoring and Internet filtering services.	
TOTAL—SCHOOL'S SHARE		R:

Category 4: Technology Support

The items in this category account for situations in which schools receive technology support from centralized staff but do not pay for it directly.

Item	Calculation	$ Amount—School's Share
Jurisdiction help desk	Total cost of providing the service, including hardware, software and staff salaries (not costs of office space, telephones, etc.)	
Centralized technology support	Costs of providing technology support to this school, including salaries, travel, supplies and other related expenses but not costs of office space, telephones, etc.	
TOTAL—SCHOOL'S SHARE		W:

Category 5: Professional Development

Professional development items in this category include professional development or training that is provided "free of charge" to school staff but not courses, conferences or workshops that teachers pay for themselves.

Item	Calculation	$ Amount—School's Share
Jurisdiction-sponsored PD and training, such as system-wide PD days, training programs, etc.	Cost of workshop instructors, materials, travel and release time for staff to attend PD sessions but not salaries of staff who attend	
TELUS Learning Connection (TLC) workshops and projects	Costs of release time for the TLC teacher-leaders to work with the school, including planning and presentation time, but not release time for participants to attend unless it is not paid by the school	
PD and training materials, including print, multimedia and online formats	Costs of materials that the jurisdiction provides to staff and schools	
TOTAL—SCHOOL'S SHARE		**BB:**

Category 6: Management and Planning

The case study is attempting to capture the cost of management and planning with respect to a single school. Therefore, activities related to the jurisdiction's technology plan are not included.

Item	Calculation	$ Amount—School's Share
Technology management and planning by central staff for this school	Costs of central office staff time to help this school in planning for and managing its technology	
Purchasing services	Cost of staff time to help this school in purchasing technology products and services	
TOTAL—SCHOOL'S SHARE		**GG:**

Add the data resulting from Part B to the data provided in Part A before completing the TCO analysis of costs in Part C.

Part C—TCO Analysis of Costs

Question to be answered	Calculation	Result
What is the total annual cost of technology in the school?	D + L + S + X + CC + HH	**JJ: $**
What proportion of the total cost of technology is spent in each category?		
1. Hardware	D/JJ times 100	%
2. Resources	L/JJ times 100	%
3. Infrastructure	S/JJ times 100	%
4. Technology Support	X/JJ times 100	%
5. Professional Development	CC/JJ times 100	%
6. Management and Planning	HH/JJ times 100	%
For each computer in the school, how much is spent annually on technology?	JJ/f	$
For each student in the school, how much is spent annually on technology?	JJ/a	$

APPENDIX B
CASE STUDIES

The TCO instrument in Appendix A was developed and field-tested by conducting case studies in 13 schools representing seven school jurisdictions in Alberta. The sample included both urban and rural elementary, junior high, middle and senior high schools.

The data collected during the case studies provides a snapshot of the costs of technology in these schools during the 1999/2000 school year. The sample is not large enough, however, to be able to draw conclusions that would apply to all schools.

Six categories of costs are included in the analysis: hardware, resources, infrastructure, technology support, professional development, and management and planning.

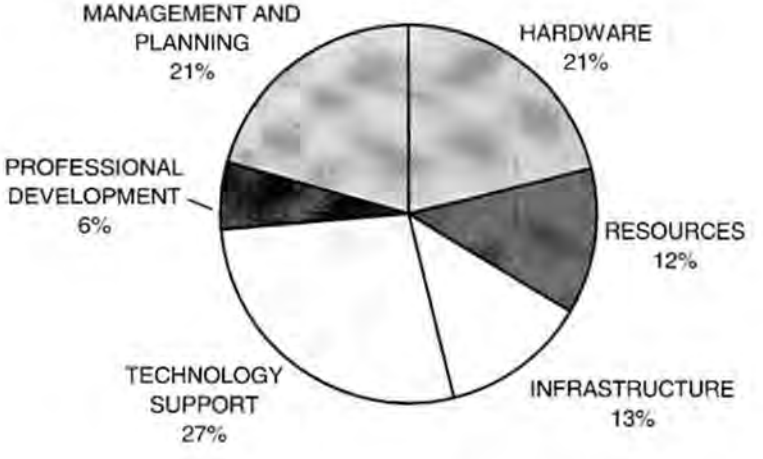
School	Level	Student-to-computer ratio	Annual cost per student	Annual cost per computer
A	Elementary	6.0	$272	$1458
B	Elementary	3.6	$238	$632
C	Elementary	9.8	$176	$1005
D	Elementary	7.9	$217	$1576
E	Jr. High/Middle	4.4	$442	$1463
F	Jr. High/Middle	6.6	$276	$1330
G	Jr. High/Middle	5.4	$350	$1356
H	Jr. High/Middle	9.3	$314	$1574
I	Jr. High/Middle	5.3	$232	$896
J	Jr. High/Middle	8.5	$211	$1246
K	Senior High	5.3	$276	$1106
L	Senior High	2.4	$678	$1552
M	Senior High	4.6	$342	$1492

SNAPSHOT OF SAMPLE ALBERTA SCHOOLS

School A—Case Study

Note: For details of the TCO instrument, see Appendix A.

Level	Elementary
Location	Urban
Number of FTE students	428
Total number of computers for students and staff	80
Student-to-computer ratio	6.0 to 1
Total annual cost of technology	$116,630
Annual cost of technology per computer	$1458
Annual cost of technology per student	$272



School A opened in September 1992. The students are divided into 20 small classes, two classes of ECS and three classes of each grade from one to six.

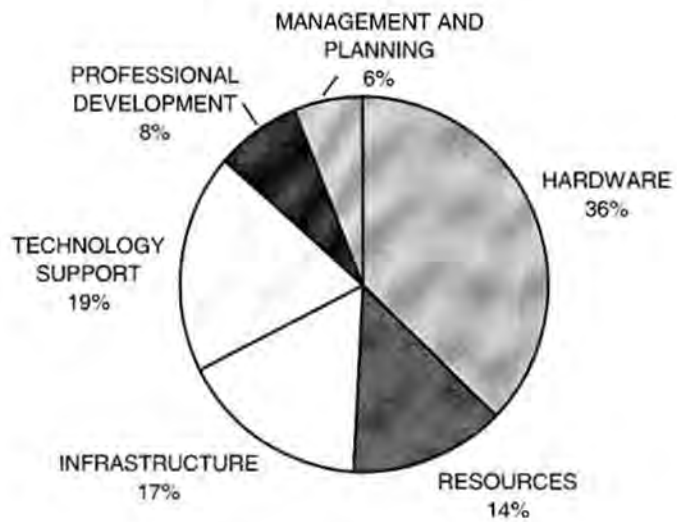
There are computers for students to use all over the school. Every classroom has two work stations. There are 11 in the library with a printer and a scanner. There are two pods of 15 computers in the wide hallways of the primary wing and the upper elementary wing of the school. In addition, the teachers have an open door policy, so that students can use the computers in other classrooms if they are not being used.

The teachers share the use of the classroom stations with students, using them for e-mail, Internet and to create student progress reports. Every classroom has a television with a VCR that is also connected to one of the computers for demonstration purposes.

School B—Case Study

Note: For details of the TCO instrument, see Appendix A.

Level	Elementary
Location	Urban
Number of FTE students	133
Total number of computers for students and staff	50
Student-to-computer ratio	3.6 to 1
Total annual cost of technology	$31,590
Annual cost of technology per computer	$632
Annual cost of technology per student	$238



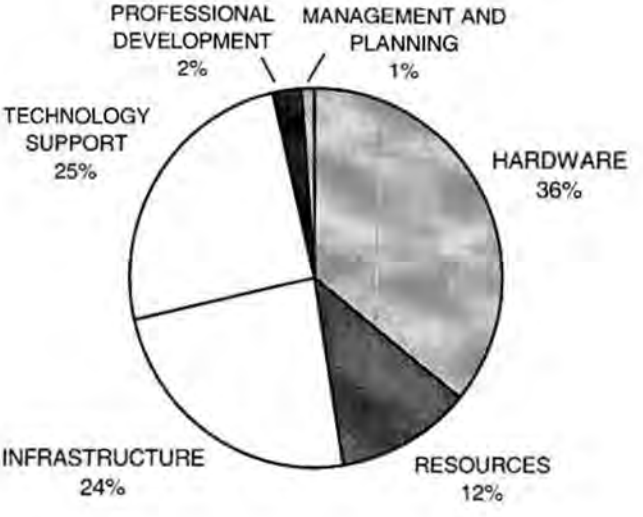
School B is over 40 years old, but it was modernized in 1999. The renovations included creating a computer lab with new Pentium work stations and providing access to the Internet from classrooms. Twenty donated computers were received from Computers for Schools. The lab now contains 33 work stations and a digital projection system for group instruction. Several classrooms have added a couple of work stations for student use as well.

A basic number of applications are installed on each work station, and the school continues to add to its collection of software each year. The lab has its own server to which students save their documents, and this server is independent of the office and teacher work stations. The office computer functions as the server for administrative applications. Teachers have access to a work station and printer in the staff room, in addition to their classroom computers. A couple of work stations have been set aside for teachers to take home to work on student progress reports.

School C—Case Study

Note: For details of the TCO instrument, see Appendix A.

Level	Elementary
Location	Suburban
Number of FTE students	370.5
Total number of computers for students and staff	65
Student-to-computer ratio	9.8 to 1
Total annual cost of technology	$65,343
Annual cost of technology per computer	$1005
Annual cost of technology per student	$176



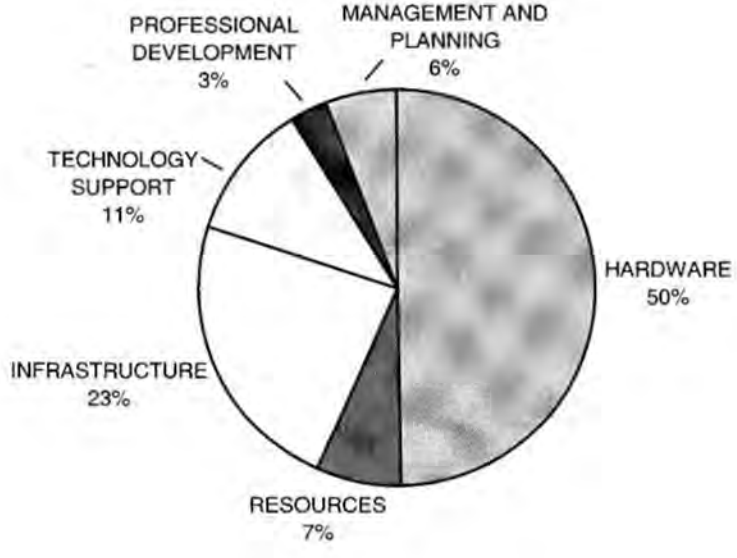
School C is in its third year of operation in a rapidly growing suburban area. When the school was staffed, skill in technology was a consideration in selection. Thus, the staff is very skilled in using technology, and the provincial ICT outcomes are achieved at each grade level. The teachers use a marks program in upper elementary, and all report cards and IPPs are produced electronically.

The original hardware in the lab is being replaced this year with 35 iMacs, in accordance with the school jurisdiction's hardware standards.

School D—Case Study

Note: For details of the TCO instrument, see Appendix A.

Level	Elementary
Location	Urban
Number of FTE students	443
Total number of computers for students and staff	61
Student-to-computer ratio	7.9 to 1
Total annual cost of technology	$96,112
Annual cost of technology per computer	$1576
Annual cost of technology per student	$217



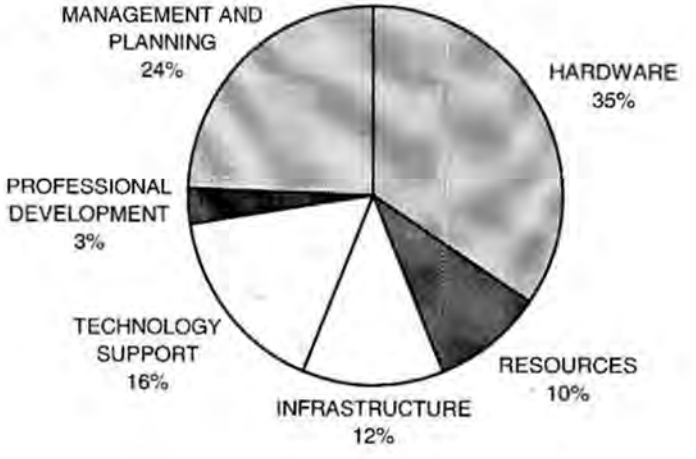
School D is a large elementary school with approximately three classes of every grade. The students come from a cross-section of the community and are largely from middle class families with two parents. The staff has a wide range of expertise with computers, and technology is being integrated across the curriculum where possible.

The school has a computer lab of 30 work stations and a work station in each classroom. Each is connected to the Internet and the school jurisdiction's WAN. The school also has a digital copier that is connected to each of the work stations.

School E—Case Study

Note: For details of the TCO instrument, see Appendix A.

Level	Middle
Location	Rural
Number of FTE students	440
Total number of computers for students and staff	133
Student-to-computer ratio	4.4 to 1
Total annual cost of technology	$194,590
Annual cost of technology per computer	$1463
Annual cost of technology per student	$442



School E is a middle school in a small town, which has two computer labs, one with 30 newer systems and the other with 25 older work stations. Most classrooms have one computer that is shared among the students and the teacher. There is a small pod of six computers in the school library.

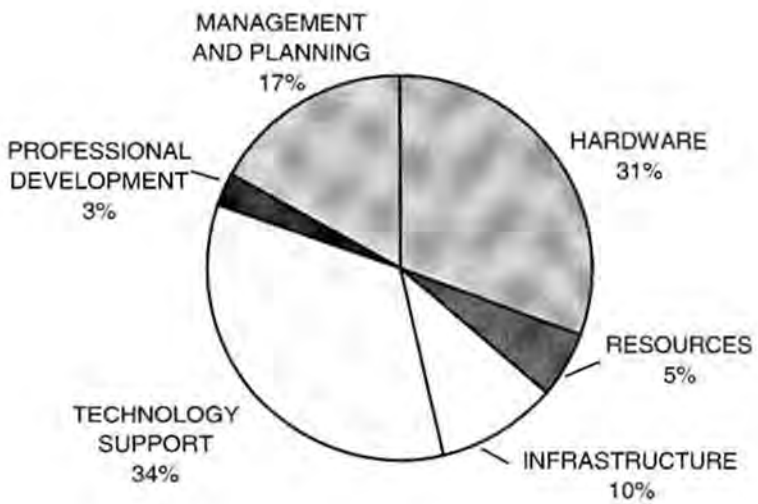
The computers are networked and have access to the Internet. Bandwidth is limited, but there are plans for high-speed access in the near future.

Students use computers across the curriculum. A mandatory skills development course is required of all students in Grade 7. In grades 8 and 9, additional complementary but optional courses are available.

School F—Case Study

Note: For details of the TCO instrument, see Appendix A.

Level	Middle
Location	Suburban
Number of FTE students	487
Total number of computers for students and staff	101
Student-to-computer ratio	6.6 to 1
Total annual cost of technology	$134,350
Annual cost of technology per computer	$1330
Annual cost of technology per student	$276



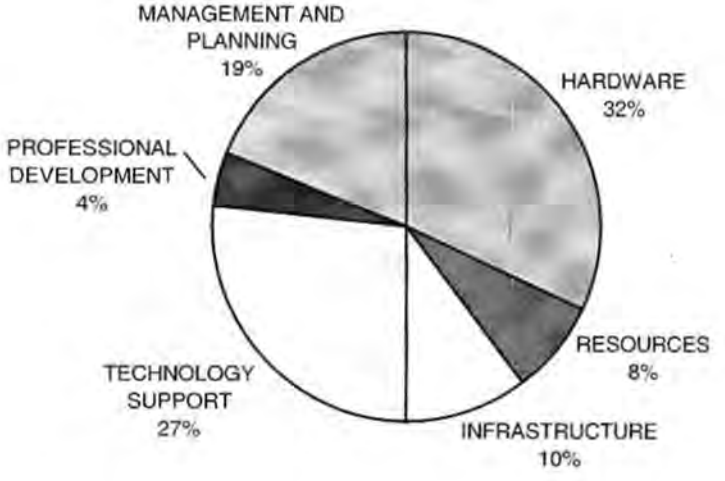
School F is a dual-track middle school in a suburban area that serves the needs of students in grades 6 to 8. The school offers programs in CTS to students in all grades as well as integrating ICT outcomes across the curriculum. Students in Grade 6 are required to take 40 hours of computer use instruction. About two-thirds of the students in grades 7 and 8 take additional computer instruction modules such as robotics, digital photography, video editing, multimedia and animation. In home economics, students at the Grade 8 level have the opportunity to learn computerized sewing.

Students have access to Macintosh computers in two computer labs, the industrial arts lab, a mini-lab in the library and a computer in each classroom. All computers are linked through 100 Base-T Ethernet to an Appleshare server and ultimately to the jurisdiction's wide area network and the Internet. Staff access computers for e-mail and administrative purposes in the classrooms, other offices and the staff room.

School G—Case Study

Note: For details of the TCO instrument, see Appendix A.

Level	Junior High
Location	Urban
Number of FTE students	434
Total number of computers for students and staff	112
Student-to-computer ratio	5.4 to 1
Total annual cost of technology	$151,859
Annual cost of technology per computer	$1356
Annual cost of technology per student	$350



School G serves an urban area with great economic diversity. Fourteen of the 15 classrooms are used as homerooms. The school has several specialty rooms: art class, CTS Foods and Fashion, CTS Construction Fabrication and Design, video conferencing room, two gymnasiums, two computer labs, a conference room and two small meeting rooms.

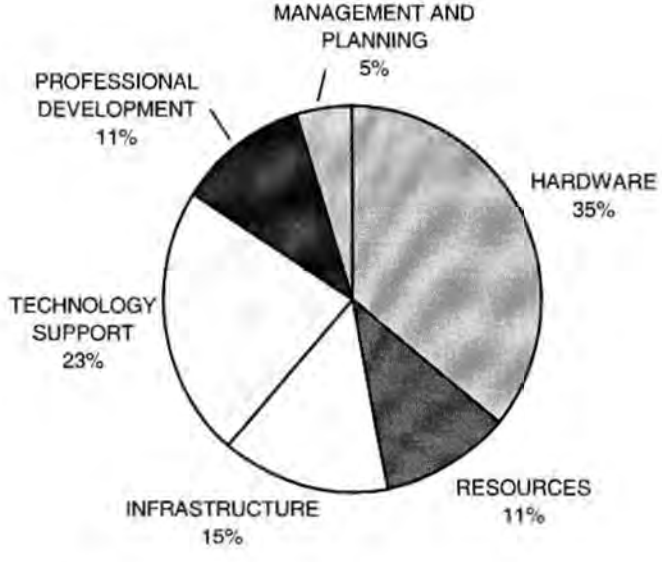
The integration of technology has been occurring since the introduction of the ICT curriculum in 1997. Information processing and multimedia option courses that used to be offered in grades 8 and 9 are now fully integrated, and each core course has one class per seven-day cycle scheduled into one of the labs.

Three servers are dedicated to student services, and the network provides over 100 stations for student access. The network supports a transfer rate of 100 megabits to the wiring closet and 100 megabits to most desktops.

School H—Case Study

Note: For details of the TCO instrument, see Appendix A.

Level	Junior High
Location	Urban
Number of FTE students	597
Total number of computers for students and staff	119
Student-to-computer ratio	9.3 to 1
Total annual cost of technology	$187,283
Annual cost of technology per computer	$1574
Annual cost of technology per student	$314



School H is a large urban junior high school that opened nine years ago. The staff are all keenly interested in educational technology and use it extensively with students.

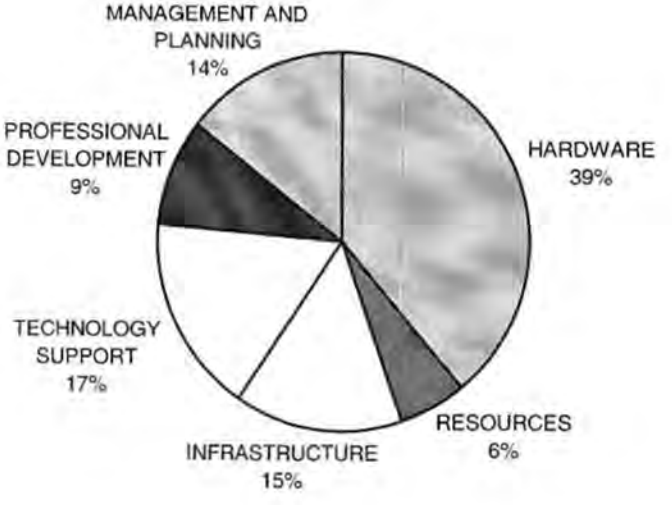
All students take a mandatory complementary course in grades 7, 8 and 9 that provides them with the skills they need to use computer technology across the curriculum. There are three computer labs with 30 or more computers in each. Two of the labs are devoted to computer courses, and the third can be booked for activities such as conducting research on the Internet and learning mathematics using a computer-managed learning system. An additional 30 computers are distributed throughout the school, mostly in classrooms.

All teachers have computer work stations for managing attendance and student marks, creating student progress reports, creating learning materials and other uses.

School I—Case Study

Note: For details of the TCO instrument, see Appendix A.

Level	Junior High
Location	Suburban
Number of FTE students	495
Total number of computers for students and staff	128
Student-to-computer ratio	5.3 to 1
Total annual cost of technology	$114,649
Annual cost of technology per computer	$896
Annual cost of technology per student	$232

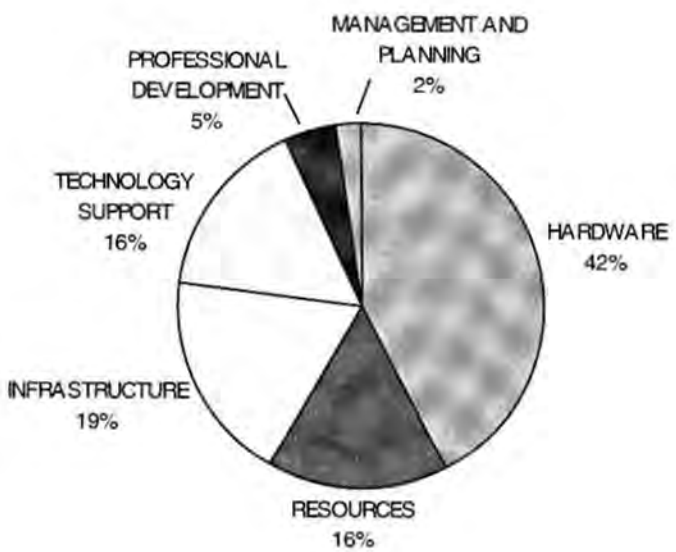


School I has a population of 497 students in grades 7 to 9. The school has three computer labs that are being upgraded from 5360s to iMacs. Together with the school's technology mentor, the staff has planned for technology integration across the curriculum. In addition, they offer a number of computer options where students are further exposed to more specialized programs. Teachers have participated in extensive professional development activity in this area, and they use various management programs daily.

School J—Case Study

Note: For details of the TCO instrument, see Appendix A.

Level	Junior High
Location	Urban
Number of FTE students	808
Total number of computers for students and staff	137
Student-to-computer ratio	8.5 to 1
Total annual cost of technology	$170,677
Annual cost of technology per computer	$1246
Annual cost of technology per student	$211



School J, a large urban junior high school that opened in September 1998, is designed with four distinct learning communities. The building was carefully planned from both an instructional and technological perspective. The plans involved:

- Designing a fully secured network environment, from the server to the work station.
- Selecting and testing applications for the whole environment.
- Purchasing and installing approximately 250 work stations in classrooms, computer labs and the school library.

The ongoing success of the environment is due in large part to the technology expertise and awareness of the school staff.

School K—Case Study

Note: For details of the TCO instrument, see Appendix A.

Level	Senior High
Location	Urban
Number of FTE students	1988
Total number of computers for students and staff	497
Student-to-computer ratio	5.3 to 1
Total annual cost of technology	$549,610
Annual cost of technology per computer	$1106
Annual cost of technology per student	$276

In School K, a large urban senior high school, students and teachers have easy access to computers throughout the school. This technology-rich environment evolved because of the strong leadership of the principal.

Features include:

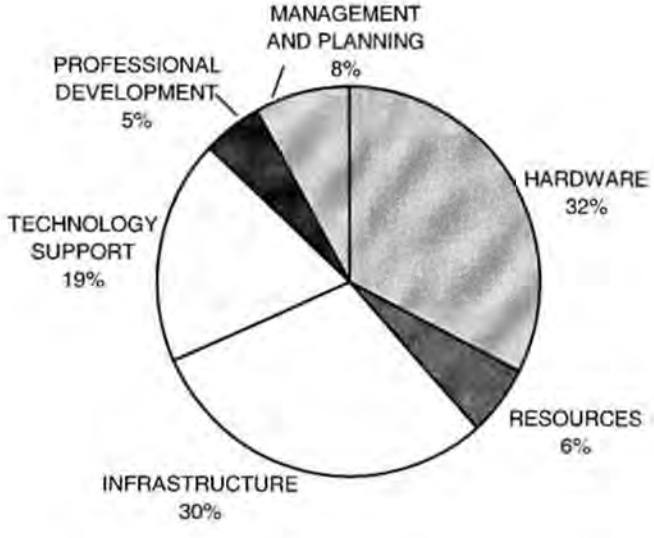
- Four Career and Technology Studies (CTS) labs, one general-purpose lab and one mathematics lab.
- 30 computers in the "book loft" in the school library that are used primarily for writing and conducting research on the Internet.
- Several clusters of between two and 10 computers in other locations, such as the mathematics department, the science department, the visual communications classroom and the remedial English classroom.
- All work stations networked with access to the Internet.

A computer system on every teacher's desk is used for managing student information, creating learning materials and communicating using e-mail and Internet.

School L—Case Study

Note: For details of the TCO instrument, see Appendix A.

Level	Senior High
Location	Rural
Number of FTE students	621
Total number of computers for students and staff	271
Student-to-computer ratio	2.4 to 1
Total annual cost of technology	$420,725
Annual cost of technology per computer	$1552
Annual cost of technology per student	$678



School L, a rural school for students in grades 9 to 12, is the largest school in the jurisdiction. The school provides a full range of programs, including academics, CTS, fine arts, IOP, community transitions and extracurricular activities.

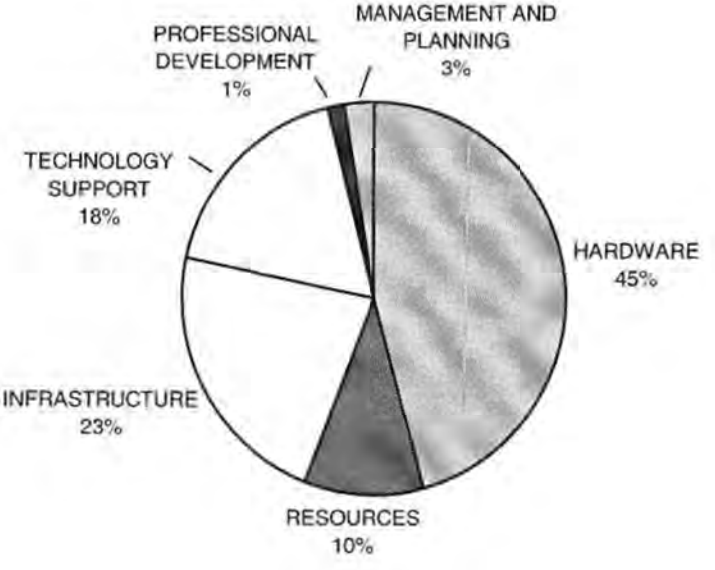
The jurisdiction is highly decentralized, with site-based management, so the school management team makes most technology decisions. Decisions about the school network or the wide area network are made in consultation with the jurisdiction technology coordinator and technical support staff to ensure that they support jurisdictional goals and objectives.

The school has 271 computers that are five years old or newer. Computer technology is infused into the curriculum in the core subjects, particularly in grades 9 and 10.

School M—Case Study

Note: For details of the TCO instrument, see Appendix A.

Level	Senior High
Location	Urban
Number of FTE students	790
Total number of computers for students and staff	181
Student-to-computer ratio	4.6 to 1
Total annual cost of technology	$270,092
Annual cost of technology per computer	$1492
Annual cost of technology per student	$342



School M offers a comprehensive academic program of studies for senior high students, including options, fine arts, co-curricular activities and the International Baccalaureate program.

Two of the school's three computer labs serve the Information and Communication Technology program, and the third is for use on an as-needed basis for other subject areas. There are 15 networked stations in the math/science wing and computer pods of three to five stations in classrooms throughout the school. The school library has 16 computers for student use as well as four non-networked stations. Each classroom also has a computer work station.

During recent renovations, large screen televisions and VCRs connected to PCs were installed in science and social studies classrooms. A technology centre with six audio-video stations was also created for production of a weekly student television segment, presentations created by students for assemblies, and advertising and community services.

APPENDIX C
SURVEYING THE SATISFACTION OF STUDENTS AND STAFF

Student Learning				
Measures of Satisfaction	*Dissatisfied*	*Somewhat dissatisfied*	*Somewhat satisfied*	*Satisfied*
Number of students who are satisfied with the opportunities that they have to use computers to help them learn				
Number of students who are satisfied with the opportunities that they have to learn to use computers				
Hardware				
Measures of Satisfaction	*Dissatisfied*	*Somewhat dissatisfied*	*Somewhat satisfied*	*Satisfied*
Number of students who are satisfied with the number of computers available for student use				
Number of teachers who are satisfied with the number of computers available for student use				
Number of teachers who are satisfied with the number of computers available for their use				
Resources				
Measures of Satisfaction	*Dissatisfied*	*Somewhat dissatisfied*	*Somewhat satisfied*	*Satisfied*
Number of students who are satisfied with the range of technology-based learning tools and resources for student use				
Number of teachers who are satisfied with the range of technology-based learning tools and resources for student use				
Number of teachers who are satisfied with the range of technology tools for their use				
Infrastructure				
Measures of Satisfaction	*Dissatisfied*	*Somewhat dissatisfied*	*Somewhat satisfied*	*Satisfied*
Number of students who are satisfied with the speed of the network and the services that it provides				
Number of staff who are satisfied with the speed of the network and the services that it provides				

Technology Support				
Measures of Satisfaction	*Dissatisfied*	*Somewhat dissatisfied*	*Somewhat satisfied*	*Satisfied*
Number of students who are satisfied that the computers are dependable				
Number of staff who are satisfied with the technical support available to solve problems, repair computers and answer their questions				
Professional Development				
Measures of Satisfaction	*Dissatisfied*	*Somewhat dissatisfied*	*Somewhat satisfied*	*Satisfied*
Number of staff who are satisfied with the opportunities that they have to learn to use computer technology effectively				
Management and Planning				
Measures of Satisfaction	*Dissatisfied*	*Somewhat dissatisfied*	*Somewhat satisfied*	*Satisfied*
Number of staff who are satisfied with their involvement in making decisions about technology				

Survey Questions for Students

Note: Reword the survey questions as required to suit the age of the students.

Rate	*Dissatisfied*	*Somewhat dissatisfied*	*Somewhat satisfied*	*Satisfied*
How satisfied are you with the opportunities you have to use computers in school to help you learn?				
How satisfied are you with the opportunities you have to learn to use computers?				
How satisfied are you with the number of computers available for students to use?				
How satisfied are you with the technology tools and resources available for students to use?				
How satisfied are you with the speed of the network and the services that it provides?				
How satisfied are you with the reliability of the computers?				

Survey Questions for Teachers

Note: Reword the survey questions as required to suit the specific context.

Rate	*Dissatisfied*	*Somewhat dissatisfied*	*Somewhat satisfied*	*Satisfied*
How satisfied are you with the number of computers available for students to use?				
How satisfied are you with the number of computers available for teachers to use?				
How satisfied are you with the technology tools and resources available for students to use?				
How satisfied are you with the range of technology tools available for teachers to use?				
How satisfied are you with the speed of the school network and the services that it provides?				
How satisfied are you with the technical support that is available to solve problems, repair computers and answer your questions?				
How satisfied are you with the opportunities you have to learn to use computer technology effectively?				
How satisfied are you with the involvement you have in making decisions about technology?				

APPENDIX D

RATING THE QUALITY OF THE TECHNOLOGY INVESTMENT

The rating scale can be used as a self-assessment instrument for determining the value derived from the current investment in technology in a school. The indicators are grouped into seven categories. Student Learning is a general category and the other six are the cost categories identified in the TCO model.

To complete the rating scale, select one descriptor for each indicator that most closely describes the situation in the school. When complete, the rating scale will provide the school with a profile of value for its technology investment that highlights areas of success as well as areas for improvement.

Note that, throughout the rating scale, "students" refers to "most students," "staff" refers to "most staff," and so on.

Since the contents of the rating scale were developed in consultation with experts from across Alberta, it reflects their opinions. To make the rating scale as useful as possible, modify it to suit local circumstances. The scale is an excellent starting point for a discussion about value. What are the best indicators of value? How can growth be described for each indicator so that schools can plan for improvement?

Student Learning

Students learn to use technology in a variety of contexts and subjects. They also use technology in a variety of ways to enhance their learning. Value is measured in terms of the range and quality of opportunities students have to use and apply technology.

Indicators	*Early*	*Emerging*	*Mature (Target)*	*Advanced*
Quality of opportunities that students have to use technology across the curriculum	Students use technology primarily to automate routine tasks; e.g., using a word processor to complete assignments or reports.	Students are beginning to use technology to do things that cannot be done without it; e.g., to locate information on the Internet and CD-ROM reference materials.	Students use technology to represent ideas; e.g., advanced word processing, publishing and presentation software. They are beginning to use technology effectively for inquiry, problem solving, decision making and creative endeavours.	Students use technology transparently for a variety of purposes. They are able to select the appropriate tool for the task, including deciding when not to use technology.
Range of opportunities students have to learn to use and apply technology	Some, but not all, students learn to use technology in discrete technology programs.	Students learn how to use technology in at least one program.	Students learn how to use technology in language arts, mathematics, science and social studies programs.	Students learn to apply technology in a wide variety of programs. Students may also learn to use technology in the school library and during extra curricular activities. Some students in junior and senior high also take courses that prepare them for careers in a field related to technology.

Indicators	*Early*	*Emerging*	*Mature (Target)*	*Advanced*
Number of students who have the knowledge, skills and attitudes defined in the Information and Communication Technology (ICT) Program of Studies	Few students have met the acceptable standard for the appropriate divisional outcomes.	Many students have met the acceptable standard for the appropriate divisional outcomes.	85% of students have met the acceptable standard for the appropriate divisional outcomes.	More than 85% of students have met the acceptable standard for the appropriate divisional outcomes.

Hardware

Hardware refers to the computer equipment and peripheral devices used by students and staff. For example, hardware includes CPUs, disk drives, monitors, keyboards, printers and projectors. Value is measured in terms of reasonable access to the hardware for students and staff. Reasonable access is more than just the number of computers in the school, however. It also depends on where the computers are located and when they are available for students and staff to use.

Indicators	*Early*	*Emerging*	*Mature (Target)*	*Advanced*
Number of computers for students	The student-to-computer ratio is 12-to-1 or better.	The student-to-computer ratio is 8-to-1 or better.	The student-to-computer ratio is 6-to-1 or better.	The student-to-computer ratio is 5-to-1 or better.
Locations of computers	Access is limited to a single type of location, such as classrooms, labs or the library.	Students have access to computers in a couple of types of locations.	Students have access to computers in a few types of locations.	Students have easy access to computers in a variety of locations throughout the school.
When computers are available for students to use	The schedule is set and inflexible; e.g., 30 minutes per week.	In addition to the set schedule, there is some time for additional access upon request.	Although a schedule exists, most of the time students can arrange to use a computer.	Computers are available for students to use whenever they need access.
Age of work stations	Most work stations are more than five years old.	Most work stations are more than five years old.	Most work stations are five years old or less.	All work stations are five years old or less.
Level of access that students with special needs have to specialized technologies that help them to learn	Technology is used to supplement learning for some students with special needs by providing tutorials and drill and practice.	Technology provides students with special needs with alternative methods of communication, such as word processing and voice recognition technologies.	Students with special needs have access to common applications through adaptive devices such as specialized keyboards, enhanced monitors and alternative mouse devices.	All students who have special needs have reasonable access to specialized technologies. In some cases, individual students have full-time access to accommodate special needs.
Level of access to computers for teachers	Teachers share access to computers with students.	A few computers, located in the staff room or department offices, are shared among several teachers.	All classrooms have at least one computer that teachers can use.	Teachers have access to computer work stations in a variety of locations whenever they need them.

Resources

Resources are the software, applications, content, Internet subscriptions and consumable supplies used by students and staff. Resources also include print materials, such as textbooks and manuals, used by students and staff to learn how to use technology. Value is measured in terms of the number, quality and variety of resources available to students and staff.

Indicators	*Early*	*Emerging*	*Mature (Target)*	*Advanced*
Range of technology-based learning resources for students	A basic suite of applications is installed on all student work stations.	In addition to a basic software suite, a few other applications are available on some work stations.	In addition to a basic software suite and other applications, an Internet browser and a few special interest resources are available on most work stations.	A wide variety of applications and resources are available on a variety of topics; e.g., CD-ROM and DVD reference materials, Internet subscription services.
Range of technology tools for teachers	A basic suite of applications is installed on all teacher work stations.	In addition to a basic software suite, teachers' work stations have a marks manager or grade book.	Teachers' work stations have a basic suite of applications, a marks manager, an Internet browser and a few special purpose applications.	Teachers' work stations include a comprehensive suite of applications, an Internet browser, an e-mail client and specialized tools for taking attendance, calculating marks and creating progress reports and IPPs.

Infrastructure

Infrastructure includes all components that are provided in the school building to make it possible to add computer work stations to the network, which consists of the school's local area network, the jurisdiction's wide area network and the Internet. Value is measured in terms of the speed and functionality of the network, as well as locations in which it can be accessed.

Indicators	*Early*	*Emerging*	*Mature (Target)*	*Advanced*
The speed of the school's network	Shared 10 megabits to the desktop	Switched 10 megabits to the desktop	Mixture of switched 10 and 100 megabits to the desktop	Switched 100 megabits to the desktop
The school's WAN connection	Analogue, Switched 56, or ISDN	Half duplex fixed bandwidth, possibly asymmetric (upstream faster than downstream)	Full duplex fixed symmetric bandwidth with ongoing bandwidth usage monitoring	Scalable full duplex symmetric with burst capacity, stated committed information rate (CIR), quality of service (QOS) features and bandwidth management features
The level of security of the school's network	No user-level security, configuration protection or virus protection	Desktop configuration security in place, including virus protection; user files server-based; AUP in place; Internet access firewall protected	Server-based user files with backup and individual user authentication, local configuration protection, virus protection. Identified system administrator. Broadband WAN with head end security services (virus, firewall)	Audit capability, standardized lock-down and/or automated reconfiguration through directory services and/or group policies, automated enterprise virus protection, generic security policies

Indicators	*Early*	*Emerging*	*Mature (Target)*	*Advanced*
Level of access to the Internet for students	One or two work stations are available for students to access the Internet.	Most students have access to the Internet in a single location such as a lab or the library.	Internet access is available in multiple locations throughout the school, including classrooms.	Internet access is available on all work stations throughout the school.
Amount of staff access to e-mail	Only office staff and administrators have e-mail accounts.	Some staff have e-mail accounts.	Many staff have e-mail accounts.	All staff have e-mail accounts.

Technology Support

Technology support is the service provided by school staff, jurisdiction staff, vendors or third-party contractors to keep the hardware, software and infrastructure functioning effectively and efficiently. Value is measured in terms of the reliability of the system and the timeliness of support.

Indicators	*Early*	*Emerging*	*Mature (Target)*	*Advanced*
The reliability of work stations	Some work stations require frequent repairs; some are not functional.	Work stations are somewhat unreliable. There has been some downtime this year due to the need for repairs.	Most work stations are reliable. There have been only a few repairs this year.	All work stations are highly reliable. There have been few repairs this year.
The reliability of the network	The network is unreliable.	The network was down a few times this year.	The network is reliable, but it has been down one or two times this year.	The network is highly reliable; there has been no downtime this year.
The timeliness of technology support	Support is initiated within a week or two.	Support is initiated within three days.	Support is initiated within 24 hours.	Support is initiated immediately.

Professional Development

Professional development (PD) refers to activities that are used to assist teachers, support staff, administrators and other staff in learning to use technology effectively and efficiently. Value cannot simply be measured in terms of the opportunities staff have to participate in PD activities. It must also be measured in relation to the purpose of the PD, which is an increase in the expertise of staff.

Indicators	*Early*	*Emerging*	*Mature (Target)*	*Advanced*
Number of staff who have the foundation skills to use technology effectively and efficiently	Staff are skilled in computer operations, file management and word processing.	Staff are also skilled in using electronic mail and the Internet.	Staff are also skilled in applying their knowledge and skills to new situations.	Staff are also skilled in data management and can select the appropriate tool for the task.
Level of staff understanding and expertise related to security issues	Staff are naïve about security issues and do not know what to do to prevent or deal with threats to data or systems.	Staff have a limited understanding of security issues and struggle with security requirements such as changing passwords.	Staff understand how data and systems can be compromised and are able to comply with security requirements such as changing passwords.	Staff are able to identify and respond to new situations that might compromise data and systems.
Level of teacher expertise in using technology for teaching	Teachers use a word processor to create student materials.	Teachers also use technology to locate relevant and up-to-date information and to create presentations to enhance teaching.	Teachers also use technology to manage student information, such as taking attendance, managing marks and creating progress reports and IPPs.	Teachers also use technology for advanced purposes, such as creating classroom web pages, including digital images in newsletters and creating online learning materials.

Indicators	*Early*	*Emerging*	*Mature (Target)*	*Advanced*
Level of teacher expertise in using technology for student learning	Teachers rely on one or two instructional strategies when using technology with students.	Teachers rely on a few instructional strategies when using technology with students.	Teachers use several different instructional strategies when using technology.	Teachers use a wide variety of instructional strategies and are able to create new ways of using technology to enhance student learning.
Management and Planning Management and planning includes budget planning for technology as well as the management of technology infrastructure, hardware and resources. Value is measured in terms of the results and the quality of the management and planning processes that are used.				
Indicators	*Early*	*Emerging*	*Mature (Target)*	*Advanced*
The quality of technology planning	Planning for technology is informal and generally occurs in response to expenditures.	The written school technology plan consists primarily of lists of hardware and other proposed expenses.	The school technology plan is focused on teaching and learning. It includes goals, action plans and a budget.	The school technology plan is not a separate process and document. It is incorporated into the school's three-year plan.
The extent to which technology resources are organized efficiently	There is no inventory of technology assets. Software masters are stored in classrooms, labs and offices. Outdated and unused hardware and software products are stored in various locations throughout the school.	An informal inventory of technology assets exists but the accuracy of the information is questionable. Hardware and software is upgraded or replaced as needed. Disposing of older technology occurs infrequently.	An inventory of all technology assets is maintained. Original software masters, such as CD-ROMs, are organized and stored in a secure location. Disposing of older technology occurs occasionally.	In addition to maintaining an accurate inventory of all technology assets and storing original software masters in a secure location, the school regularly upgrades, replaces and disposes of technology assets as part of a well-defined plan.
The level of staff involvement in making decisions about technology goals, expenditures and implementation	A computer coordinator, a key "computer teacher" or the school secretary makes most of the decisions about technology.	A committee of staff makes most of the decisions about technology.	All staff provide input to decisions about technology and understand how purchases are made.	All staff provide input to decisions about technology and understand how purchases are made.
The role of the principal in providing leadership related to technology	The principal relies on a few staff members to provide leadership related to technology.	The principal plays a limited role in providing leadership related to technology.	The principal is a role model in using technology effectively and has a clear vision of how technology can be used to enhance student learning.	The principal is able to help staff to envision new ways to use technology to enhance student learning.

APPENDIX E
PLANNING SCENARIOS

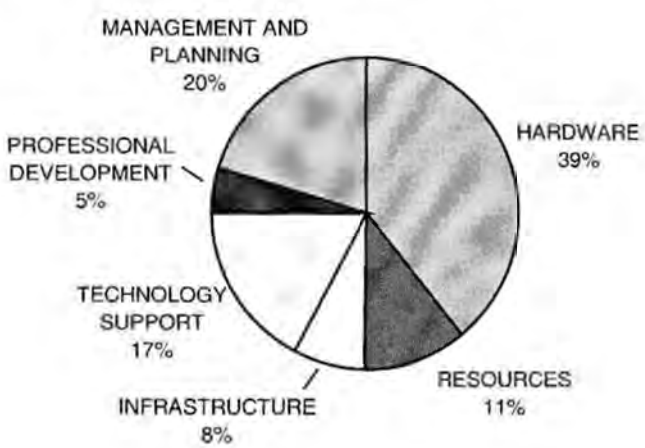
The TCO instrument can be used to plan a budget for technology in a school, as shown by the two different scenarios provided in this appendix. In both cases, the contributors were asked to create a technology budget for a new school—a senior high school and a middle school. They began with their own assumptions of the best-case scenario. In both cases, the participants found that the TCO instrument was an effective way to create a detailed budget plan for technology.

Since the planning scenarios are based on the assumptions of the contributors, they are a matter of opinion. They do not describe government policies or jurisdictional standards. According to the contributors, they are realistic and provide good value.

Scenario No. 1

Scenario No. 1, a plan for a rural middle school that will be opened within the next two years, was prepared by a team of school and jurisdiction administrators who have been charged with planning the new school. The team began by completing a TCO analysis of the existing school and then extrapolating costs based on their desire to provide better access to technology. The plan is modest and realistic because it does not assume that everything in the school will be new. Some of the hardware and resources from the existing school will be moved to the new one.

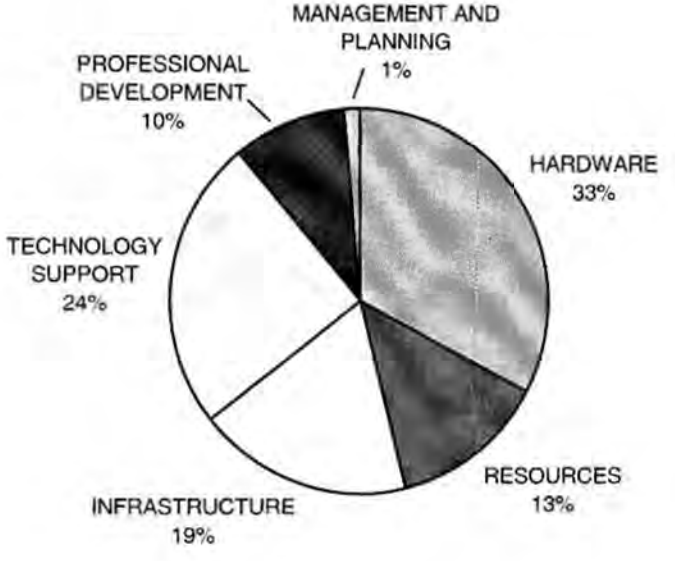
Level	Middle
Location	Rural
Number of FTE students	440
Total number of computers for students and staff	133
Student-to-computer ratio	4.4 to 1
Total annual cost of technology	$240,110
Annual cost of technology per computer	$1805
Annual cost of technology per student	$546



Scenario No. 2

Scenario No. 2, a plan for a mid-sized urban senior high school, was prepared by a teacher-consultant who has had extensive experience in a similar setting. The hypothetical school has three computer labs for CTS and one each for mathematics, second languages and other curricular areas, along with a partial lab in the library, five computers in student services, and 23 computers in other locations such as communications technology, electronics and foods. There is one computer in each classroom in addition to work stations in the office, staff room and department work areas.

Level	Senior High
Location	Urban
Number of FTE students	1100
Total number of computers for students and staff	295
Student-to-computer ratio	4.9 to 1
Total annual cost of technology	$370,726
Annual cost of technology per computer	$1257
Annual cost of technology per student	$337



School:	Scenario #1
Total number of full-time equivalent (FTE) students in the school, excluding home schoolers	440
Total number of FTE staff in the school who are users of computer technology	54.5
Total number of FTE computer users in the school (students and staff)	494.5
Total number of computer work stations for student use that are five years old or newer (by manufacturer's date)	101
Total number of computer work stations for staff use that are five years old or newer (by manufacturer's date), and are not shared with students	32
Total number of computer work stations that are five years old or newer	133
Student-to-computer ratio	4.4

Category 1: Hardware

Hardware refers to the computer equipment and peripheral devices used by students and staff. Include all hardware that is five years old or newer, and that is in active use by both students and staff.

Item	*Input*	*$ Amount*
Computer work stations	Initial cost of all work stations five years old or newer, or, if leased, total cost over five years	$409,224.00
Computer printers	Initial cost of all printers five years old or newer	$31,000.00
Other peripherals, such as computer projection systems, scanners, digital cameras and personal digital assistants (PDAs)	Initial cost of all peripherals five years old or newer	$28,800.00
TOTAL ANNUAL COST		$93,804.80

Category 2: Resources

Resources are the software, applications, Internet subscriptions, print materials and consumable supplies used by students and staff. Resources are assumed to have a depreciation period of five years, unless they are consumable.

Item	*Input*	*$ Amount*
Standard general purpose software applications on all work stations; e.g., office suite	Total amount spent, including initial cost and upgrades	$88,500.00

Technology-based learning resources, such as CD-ROMs and special purpose instructional software	Total amount spent, including initial cost and upgrades	$8500.00
Management applications, such as a student marks program, student information system, library automation system and school-based accounting	Total amount spent including initial cost and upgrades (school-level costs only)	$10,000.00
Print materials, such as textbooks and manuals that support the use of technology	Initial costs of all print materials that are five years old or newer	$2000.00
Subscription services and other annual fees for resources; e.g., Electronic Library, Web Links	Total amount spent this year on licensing fees	$1000.00
Consumable supplies, such as printer paper, toner/ink cartridges, backup tapes and disks	Total amount spent this year on consumables	$1800.00
The school's share of costs covered by the jurisdiction on behalf of schools	Include annual costs in any of the sub-categories above.	$2000.00
TOTAL ANNUAL COST		$26,600.00

Category 3: Infrastructure

Infrastructure includes all components that are provided in the school building to make it possible to add computer work stations to the network, which consists of the school's local area network, the jurisdiction's wide area network and the Internet.

Item	*Input*	*$ Amount*
Wired locations; i.e., drops for work stations	Total amount spent, including cable, conduit and labour (include extra electrical outlets installed for computer work stations)	$2830.00
Network hubs, switches, routers and racks	Initial costs, including hardware and labour	$10,000.00
Network servers, including related software, resources, UPS and backup systems	Initial costs, including hardware, software and labour	$4000.00
Monthly charges for electrical power, ISP and WAN	Total amount spent in one year on monthly charges for electrical power, Internet service and WAN (school-level costs only)	$11,531.00
Computer furniture	Total amount spent on additional furniture required to support technology in the school; e.g., computer desks, computer chairs, printer stands, projection screens and other furniture	$2200.00
The school's share of costs covered by the jurisdiction on behalf of schools	Annual costs in any of the sub-categories above plus shared costs of the wide area network	$2000.00
TOTAL ANNUAL COST		$18,533.00

Category 4: Technology Support

Technology support is the service provided by school staff, jurisdiction staff, vendors or third-party contractors to install the hardware, software and infrastructure and to keep it functioning effectively and efficiently. It also includes the cost of maintaining the school's web site or intranet. Technology support includes formal technology support only, not informal support such as staff helping each other to solve problems. Include data related to technology support for all hardware, regardless of age.

Item	*Input*	*$ Amount*
School network operator or school technology support staff	Total amount spent per year or number of hours multiplied by average staff costs	$2640.00
Maintenance and support contracts with third-party contractors or vendor support paid for by the school	Total amount spent per year of contracts or vendor fees	$1508.00
Installations, repairs and upgrades of all hardware and infrastructure components, including replacements due to theft or vandalism	Costs per year	$4000.00
The school's share of costs covered by the jurisdiction on behalf of schools	Annual cost of technology support in the school that is paid for by the jurisdiction and not by the school	$32,914.00
TOTAL ANNUAL COST		$41,062.00

Category 5: Professional Development

Professional development (PD) refers to activities such as training workshops that are used to help staff use technology effectively and efficiently. Include PD for all adult users of computer systems in the school, including technology support staff and administrative support staff. PD includes formal activities only, not informal activities such as staff helping each other to learn new things.

Item	*Input*	*$ Amount*
Cost of release time for staff to attend professional development and training activities	Total number of days per year for all staff multiplied by the cost of supply staff per day	$2520.00
Cost of time for school-based workshop leaders to conduct professional development and training activities	Total number of hours or days per year, including preparation, presentation and follow-up, multiplied by average teacher salaries per hour or day	$3350.00
Cost of workshops, conferences and other PD activities provided by staff or organizations outside of the school	Total cost per year including consulting fees, registration fees, travel and expenses	$1500.00
The school's share of costs covered by the jurisdiction on behalf of schools	Annual cost of PD that is paid for by the jurisdiction and not by the school	$4000.00
TOTAL ANNUAL COST		$11,370.00

Category 6: Management and Planning

Management and planning includes budget planning for technology as well as the management of technology infrastructure, hardware and resources.

Item	*Input*	*$ Amount*
Cost of staff time spent on technology planning activities, such as committee work	Total number of hours/days per year, including research, writing and meetings, multiplied by average staff salaries	$1260.00
Cost of staff time spent on managing the infrastructure, hardware and resources	Total number of hours/days per year, including ordering, recording and taking inventory, multiplied by average staff salaries	$40,000.00
Cost of external consultants or vendors involved in technology planning with the school	Total costs per year, such as consulting fees	$1500.00
The school's share of costs covered by the jurisdiction on behalf of schools	Annual costs in any of the sub-categories above that are directly related to the school (not jurisdiction-level planning for technology)	$5980.00
TOTAL ANNUAL COST		$48,740.00

TOTAL BUDGET—SCENARIO NO. 1	$240,100.00

School:	Scenario #2
Total number of full-time equivalent (FTE) students in the school, excluding home schoolers	1100
Total number of FTE staff in the school who are users of computer technology	70
Total number of FTE computer users in the school (students and staff)	1170
Total number of computer work stations for student use that are five years old or newer (by manufacturer's date)	223
Total number of computer work stations for staff use that are five years old or newer (by manufacturer's date), and are not shared with students	72
Total number of computer work stations that are five years old or newer	295
Student-to-computer ratio	4.9

Category 1: Hardware

Hardware refers to the computer equipment and peripheral devices used by students and staff. Include all hardware that is five years old or newer, and that is in active use by both students and staff.

Item	*Input*	*$ Amount*
Computer work stations	Initial cost of all work stations five years old or newer, or, if leased, total cost over five years	$545,750.00
Computer printers	Initial cost of all printers five years old or newer	$41,200.00
Other peripherals, such as computer projection systems, scanners, digital cameras and personal digital assistants (PDAs)	Initial cost of all peripherals five years old or newer	$20,460.00
TOTAL ANNUAL COST		$121,482.00

Category 2: Resources

Resources are the software, applications, Internet subscriptions, print materials and consumable supplies used by students and staff. Resources are assumed to have a depreciation period of five years, unless they are consumable.

Item	*Input*	*$ Amount*
Standard general purpose software applications on all work stations; e.g., office suite	Total amount spent, including initial cost and upgrades	$46,610.00

Technology-based learning resources, such as CD-ROMs and special purpose instructional software	Total amount spent, including initial cost and upgrades	$30,000.00
Management applications, such as a student marks program, student information system, library automation system and school-based accounting	Total amount spent including initial cost and upgrades (school-level costs only)	$28,548.00
Print materials, such as textbooks and manuals that support the use of technology	Initial costs of all print materials that are five years old or newer	$1000.00
Subscription services and other annual fees for resources; e.g., Electronic Library, Web Links	Total amount spent this year on licensing fees	$3392.97
Consumable supplies, such as printer paper, toner/ink cartridges, backup tapes and disks	Total amount spent this year on consumables	$6750.00
The school's share of costs covered by the jurisdiction on behalf of schools	Include annual costs in any of the sub-categories above.	$17,626.00
TOTAL ANNUAL COST		$49,000.57

Category 3: Infrastructure

Infrastructure includes all components that are provided in the school building to make it possible to add computer work stations to the network, which consists of the school's local area network, the jurisdiction's wide area network and the Internet.

Item	*Input*	*$ Amount*
Wired locations; i.e., drops for work stations	Total amount spent, including cable, conduit and labour (include extra electrical outlets installed for computer work stations)	$132,000.00
Network hubs, switches, routers and racks	Initial costs, including hardware and labour	$39,880.00
Network servers, including related software, resources, UPS and backup systems	Initial costs, including hardware, software and labour	$72,480.00
Monthly charges for electrical power, ISP and WAN	Total amount spent in one year on monthly charges for electrical power, Internet service and WAN (school-level costs only)	$8,565.00
Computer furniture	Total amount spent on additional furniture required to support technology in the school; e.g., computer desks, computer chairs, printer stands, projection screens and other furniture	$104,500.00
The school's share of costs covered by the jurisdiction on behalf of schools	Annual costs in any of the sub-categories above plus shared costs of the wide area network	$7140.00
TOTAL ANNUAL COST		$68,925.00

Category 4: Technology Support

Technology support is the service provided by school staff, jurisdiction staff, vendors or third-party contractors to install the hardware, software and infrastructure and to keep it functioning effectively and efficiently. It also includes the cost of maintaining the school's web site or intranet. Technology support includes formal technology support only, not informal support such as staff helping each other to solve problems. Include data related to technology support for all hardware, regardless of age.

Item	*Input*	*$ Amount*
School network operator or school technology support staff	Total amount spent per year or number of hours multiplied by average staff costs	$52,000.00
Maintenance and support contracts with third-party contractors or vendor support paid for by the school	Total amount spent per year of contracts or vendor fees	$2116.66
Installations, repairs and upgrades of all hardware and infrastructure components, including replacements due to theft or vandalism	Costs per year	$36,000.00
The school's share of costs covered by the jurisdiction on behalf of schools	Annual cost of technology support in the school that is paid for by the jurisdiction and not by the school	$0.00
TOTAL ANNUAL COST		$90,116.66

Category 5: Professional Development

Professional development (PD) refers to activities such as training workshops that are used to help staff use technology effectively and efficiently. Include PD for all adult users of computer systems in the school, including technology support staff and administrative support staff. PD includes formal activities only, not informal activities such as staff helping each other to learn new things.

Item	*Input*	*$ Amount*
Cost of release time for staff to attend professional development and training activities	Total number of days per year for all staff multiplied by the cost of supply staff per day	$17,000.00
Cost of time for school-based workshop leaders to conduct professional development and training activities	Total number of hours or days per year, including preparation, presentation and follow-up, multiplied by average teacher salaries per hour or day	$17,428.00
Cost of workshops, conferences and other PD activities provided by staff or organizations outside of the school	Total cost per year including consulting fees, registration fees, travel and expenses	$1400.00
The school's share of costs covered by the jurisdiction on behalf of schools	Annual cost of PD that is paid for by the jurisdiction and not by the school	$0.00
TOTAL ANNUAL COST		$35,828.00

Category 6: Management and Planning

Management and planning includes budget planning for technology as well as the management of technology infrastructure, hardware and resources.

Item	*Input*	*$ Amount*
Cost of staff time spent on technology planning activities, such as committee work	Total number of hours/days per year, including research, writing and meetings, multiplied by average staff salaries	$978.00
Cost of staff time spent on managing the infrastructure, hardware and resources	Total number of hours/days per year, including ordering, recording and taking inventory, multiplied by average staff salaries	$3500.00
Cost of external consultants or vendors involved in technology planning with the school	Total costs per year, such as consulting fees	$784.00
The school's share of costs covered by the jurisdiction on behalf of schools	Annual costs in any of the sub-categories above that are directly related to the school (not jurisdiction-level planning for technology)	$112.00
TOTAL ANNUAL COST		$5374.00

TOTAL BUDGET—SCENARIO NO. 2	$ 370,726.00

Calculating the Costs of Technology
Sample Spreadsheet

General Data

School:	Insert Name of School
Total number of full-time equivalent (FTE) students in the school, excluding home schoolers	428
Total number of FTE staff in the school who are users of computer technology	30
Total number of FTE computer users in the school (students and staff)	**458**
Total number of computer work stations for student use that are five years old or newer (by manufacturer's date)	71
Total number of computer work stations for staff use that are five years old or newer (by manufacturer's date), and are not shared with students	9
Total number of computer work stations that are five years old or newer	**80**
Student-to-computer ratio	**6.0**

Category 1: Hardware

Hardware refers to the computer equipment and peripheral devices used by students and staff. Include all hardware that is five years old or newer, and that is in active use by both students and staff.

Item	*Input*	*$ Amount*
Computer work stations	Initial cost of all work stations five years old or newer, or, if leased, total cost over five years	$106,500.00
Computer printers	Initial cost of all printers five years old or newer	$8,600.00
Other peripherals, such as computer projection systems, scanners, digital cameras and personal digital assistants (PDAs)	Initial cost of all peripherals five years old or newer	$8,500.00
TOTAL ANNUAL COST		**$24,720.00**

Category 2: Resources

Resources are the software, applications, Internet subscriptions, print materials and consumable supplies used by students and staff. Resources are assumed to have a depreciation period of five years, unless they are consumable.

Item	*Input*	*$ Amount*
Standard general purpose software applications on all work stations; e.g., office suite	Total amount spent, including initial cost and upgrades	$4,000.00
Technology-based learning resources, such as CD-ROMs and special purpose instructional software	Total amount spent, including initial cost and upgrades	$2,000.00
Management applications, such as a student marks program, student information system, library automation system and school-based accounting	Total amount spent including initial cost and upgrades (school-level costs only)	$1,000.00
Print materials, such as textbooks and manuals that support the use of technology	Initial costs of all print materials that are five years old or newer	$1,000.00
Subscription services and other annual fees for resources; e.g., Electronic Library, Web Links	Total amount spent this year on licensing fees	$500.00
Consumable supplies, such as printer paper, toner/ink cartridges, backup tapes and disks	Total amount spent this year on consumables	$7,000.00
The school's share of costs covered by the jurisdiction on behalf of schools	Include annual costs in any of the sub-categories above.	$5,350.00
TOTAL ANNUAL COST		**$14,450.00**

Category 3: Infrastructure

Infrastructure includes all components that are provided in the school building to make it possible to add computer work stations to the network, which consists of the school's local area network, the jurisdiction's wide area network and the Internet.

Item	*Input*	*$ Amount*
Wired locations; i.e., drops for work stations	Total amount spent, including cable, conduit and labour (include extra electrical outlets installed for computer work stations)	$13,000.00
Network hubs, switches, routers and racks	Initial costs, including hardware and labour	$2,000.00
Network servers, including related software, resources, UPS and backup systems	Initial costs, including hardware, software and labour	$20,000.00
Monthly charges for electrical power, ISP and WAN	Total amount spent in one year on monthly charges for electrical power, Internet service and WAN (school-level costs only)	$900.00
Computer furniture	Total amount spent on additional furniture required to support technology in the school; e.g., computer desks, computer chairs, printer stands, projection screens and other furniture	$1,000.00
The school's share of costs covered by the jurisdiction on behalf of schools	Annual costs in any of the sub-categories above plus shared costs of the wide area network	$5,564.00
TOTAL ANNUAL COST		**$14,730.67**

Category 4: Technology Support

Technology support is the service provided by school staff, jurisdiction staff, vendors or third-party contractors to install the hardware, software and infrastructure and to keep it functioning effectively and efficiently. It also includes the cost of maintaining the school's web site or intranet. Technology support includes formal technology support only, not informal support such as staff helping each other to solve problems. Include data related to technology support for all hardware, regardless of age.

Item	*Input*	*$ Amount*
School network operator or school technology support staff	Total amount spent per year or number of hours multiplied by average staff costs	$15,000.00
Maintenance and support contracts with third-party contractors or vendor support paid for by the school	Total amount spent per year of contracts or vendor fees	$0.00
Installations, repairs and upgrades of all hardware and infrastructure components, including replacements due to theft or vandalism	Costs per year	$200.00
The school's share of costs covered by the jurisdiction on behalf of schools	Annual cost of technology support in the school that is paid for by the jurisdiction and not by the school	$16,906.00
TOTAL ANNUAL COST		**$32,106.00**

Category 5: Professional Development

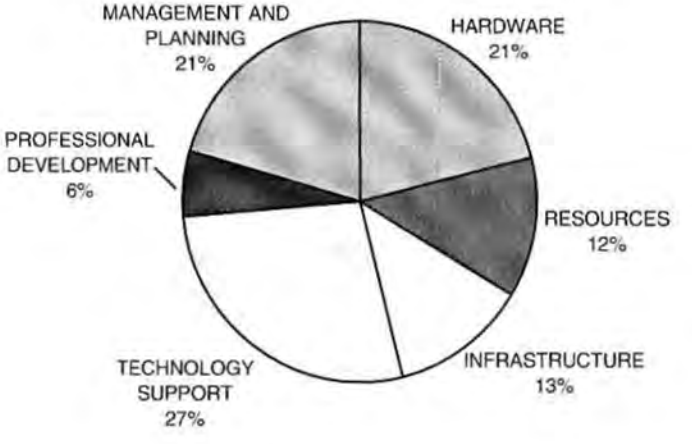
Professional development (PD) refers to activities such as training workshops that are used to help staff use technology effectively and efficiently. Include PD for all adult users of computer systems in the school, including technology support staff and administrative support staff. PD includes formal activities only, not informal activities such as staff helping each other to learn new things.

Item	*Input*	*$ Amount*
Cost of release time for staff to attend professional development and training activities	Total number of days per year for all staff multiplied by the cost of supply staff per day	$840.00
Cost of time for school-based workshop leaders to conduct professional development and training activities	Total number of hours or days per year, including preparation, presentation and follow-up, multiplied by average teacher salaries per hour or day	$1,900.00
Cost of workshops, conferences and other PD activities provided by staff or organizations outside of the school	Total cost per year including consulting fees, registration fees, travel and expenses	$1,000.00
The school's share of costs covered by the jurisdiction on behalf of schools	Annual cost of PD that is paid for by the jurisdiction and not by the school	$2,889.00
TOTAL ANNUAL COST		**$6,629.00**

Category 6: Management and Planning

Management and planning includes budget planning for technology as well as the management of technology infrastructure, hardware and resources.

Item	*Input*	*$ Amount*
Cost of staff time spent on technology planning activities, such as committee work	Total number of hours/days per year, including research, writing and meetings, multiplied by average staff salaries	$8,000.00
Cost of staff time spent on managing the infrastructure, hardware and resources	Total number of hours/days per year, including ordering, recording and taking inventory, multiplied by average staff salaries	$10,000.00
Cost of external consultants or vendors involved in technology planning with the school	Total costs per year, such as consulting fees	$0.00
The school's share of costs covered by the jurisdiction on behalf of schools	Annual costs in any of the sub-categories above that are directly related to the school (not jurisdiction-level planning for technology)	$5,992.00
TOTAL ANNUAL COST		**$23,992.00**

Analysis: Costs of Technology

What is the total annual cost of technology in the school?	$116,627.67
Hardware	21.2%
Resources	12.4%
Infrastructure	12.6%
Technology Support	27.5%
Professional Development	5.7%
Management and Planning	20.6%
What proportion of the total cost of technology is spent on computer work stations?	18.3%
For each computer work station purchased, what is the total of all other related costs throughout the five-year lifespan of the work station?	$5,957.98
For each student in the school, how much is spent annually on technology?	$272.49
For each computer in the school, how much is spent annually on technology?	$1,457.85
For each computer in the school, how much is spent during its lifespan?	$7,289.23